DOCUMENT INFORMATION

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Document No:	**Rev:**

Project Information (Check Applicable Box)

- ☐ Balance of Facilities
- ☐ Pretreatment
- ☐ HLW Vitrification
- ☒ LAW Vitrification
- ☐ Analytical
- ☐ External Interfaces
- ☐ Across all areas

Document is applicable to ALARA? ☐ Yes ☒ No

In general, any record that deals with Radiation, Radioactive Material, Occupational Dose, Dose Reduction, or Dose Rate are considered ALARA Records. (See 24590-WTP-GPP-SRAD-002, *Application of ALARA in the Design Process*, section 4.8 for additional guidance)

Additional Information for Correspondence

Subject Code(s) 4152

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Concurrence Sheet

CCN: 048470

Title	**Name**	**Concurrence required (Check appropriately)**	**Initials**	**Date**	**Order**
Project Director	R. F. Naventi	☐			
Project Manager	J. P. Betts	☐			
Deputy Project Manager	F. B. Marsh	☐			
Operations Manager	W. G. Poulson	☐			
Construction Manager	W. Clements	☐			
Business Manager	W. L. Wagner	☐			
Environmental, Safety, and Health	F. Beranek	☐			
Contracts Manager	A. R. Veirup	☒	[illegible]	12/17/02	
Project QA Manager	G. Shell	☐			
HLW Area Project Manager	P. Schuetz	☐			
LAW Area Project Manager	D. N. Patel	☒	DNP for	Bill Clements	12/16/02
Pretreatment Area Project Manager	R. E. Lawrence	☐			
BOF Area Project Manager	J. Q. Hicks	☐			
Lab Area Project Manager	P. J. Keuhlen	☐			
Process Technology	K. J. Rueter	☐			
Research and Technology	G. T. Wright	☐			
Commissioning	M. N. Brosee	☐			
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BNI Legal	D. M. Curtis	☐			
	D. Scribner	☒	DTS	12/16/02	

	Signature	Date
J. P. Betts	N/a [signature]	12/17/02
Print/Type Applicable Line Manager's Name	*Signature*	*Date*
W. T. Clements	[signature] for WC	12/16/02
Print/Type Originator's Name	*Signature*	*Date*

U.S. Department of Energy
Office of River Protection
Mr. R. J. Schepens
Manager
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

CCN: 048470

DEC 1 8 2002

Dear Mr. Schepens:

CONTRACT NO. DE-AC27-01RV14136 – LOW-ACTIVITY WASTE BASEMAT COLD JOINT

Reference: 24590-WTP-TRNS-ENS-02-019, BNI Transmittal, Tracey Ryan, BNI, to L. F. Miller, "LAW Basemat Cold Joint Report to File," dated December 12, 2002.

Bechtel National, Inc. (BNI) has completed the Engineering Report for the Low-Activity Waste (LAW) Basemat cold joint. Two copies each of the report and the references were provided via the Reference, to the U.S. Department of Energy (DOE), Office of Safety Regulation and the Defense Nuclear Facilities Safety Board.

Enclosed are the formal submittal of the report (Attachment 1) and the Olson Report, "Final Concrete Condition Assessment Report Southeast Foundation Slab Cold Joint Evaluation," (Attachment 2) which was previously submitted in draft.

This submittal completes BNI's commitment for engineering information required by the DOE prior to release of concrete placement LAW-001B, C, and D, currently scheduled for December 19, 2002.

If you have any questions, please contact William Clements at 371-3579.

Very truly yours,

R. F. Naventi
Project Director

KLK/jgv

Attachments 1. Final Low Activity Waste Basemat Cold Joint Engineering Report to File
2. Final Concrete Condition Assessment Report Southeast Foundation Slab Cold Joint Evaluation

cc:

Barrett, M. K. w/o	ORP	H6-60
Betts, J. P. w/o	WTP	MS14-3C
Clements, W. T. w/o	WTP	MS4-B1
DOE Correspondence Control w/a	ORP	H6-60
Ensign, K. R. w/o	ORP	H6-60
Erickson, L. w/o	ORP	H6-60
Hamel, W. F. w/o	ORP	H6-60
Hanson, A. J. w/o	ORP	H6-60
Hawkins, A. R. w/a	ORP	H6-60
Miller, L. F. w/a (4 copies)	OSR	H6-60
Naventi, R. F. w/o	WTP	MS14-3C
PDC w/a	WTP	MS5-K.1
Rasmussen, J. E. w/o	ORP	H6-60
Taylor, W. J. w/o	ORP	H6-60
Veirup, A. R. w/o	WTP	MS14-3B

Document title: **LOW ACTIVITY WASTE BASEMAT COLD JOINT ENGINEERING REPORT TO FILE**

Contract number: ~~DE-AC27-99RL14047~~ 12/13/02 DE-AC27-01RV14136 DTS 12/13/02

Department: CS&A

Author(s): Author Name
Greg Kasel

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Reviewed signature:

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Approved by: Don Scribner

Approver's position: Discipline Chief Engineer,
Civil, Structural & Architectural Engineering

Approver signature: DTS

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History Sheet

Rev	Date	Reason for revision	Revised by
0	12/12/02	Initial Issue	

Contents

Executive Summary

Waste Treatment Project (WTP) commenced Important to Safety construction activities authorized by Preliminary Construction Authorization (PCAR) for Low Activity Waste (LAW) facility on July 10, 2002. On July 11, 2002, LAW-001 basemat concrete placement of 1,650 cubic yards was initiated at 6:03 AM. The peak ambient temperature on July 11 exceeded 100°F. The weather and worker heat stress caused the concrete placement to be suspended prior to its completion resulting in an unplanned cold joint. This Engineering Report addresses the Department of Nuclear Facility Safety Board (DNFSB) staff concerns regarding the placement of out of specification concrete in the basemat of the LAW structure. In addition, the report summarizes the evaluation, decision making process and development of a recovery plan intended to restore the function of the structure as originally designed. The detailed basis is captured in the referenced documents.

After the concrete placement on July 11, 2002, WTP stopped all greater than 36" thick placements similar to aborted placement. A root cause analysis was performed (Ref. 5) to evaluate the incident. The analysis determined that the concrete batch plant was designed to produce specified concrete (70 °F Max) at 95°F maximum ambient temperature, well below those experienced on July 11, 2002. This should have been foreseen and a decision should have been made to defer the placement. To preclude recurrence, WTP have now revised procedures to conduct a pre-placement session, including monitoring forecast high and low ambient temperatures and establish limits well within the design of batch plant capability for a placement to be scheduled.

A systematic and structured methodology was developed to determine the adequacy of the placed concrete and to investigate improper material segregation, inadequate bonding to reinforcements, and voids, using state of the art techniques. WTP Consultant, Olson Engineering performed the Impact Echo (IE) and the Spectral Analysis of Surface Waves (SASW) Non-Destructive Testing (NDT). The IE method is a thickness/flaw resonant sound wave reflection test that is used to measure the overall thickness of a concrete slab and check for internal areas of

possible cold joints and poor consolidation. The SASW method is used to check for variations in concrete velocity (proportional to strength) with the depth from the exposed surface to check the concrete quality and estimate the depths of any weaker, poorer quality concrete. The Consultant analysis of the NDT results suggested some questionable-weak areas of concrete. The questionable areas were chipped out and a final NDT check was performed (Ref. 14).

Core bore locations were selected in both the finished areas of the base mat and the unfinished cold joint area to validate Non Destructive Test results and location of questionable quality concrete. The number of core bores was based on criteria outlined in ACI 318. The core bore test provided results that show all concrete was above the specified compressive strength (Ref. 7).

Additionally, a thermal analysis was done using the mix data, water usage, thermal data from similar pours. The analysis concluded that there is no likelihood of thermal cracking (Ref 8).

Potential for delayed ettringite formation (DEF) was evaluated by the concrete specialist. The evaluation showed very little risk of DEF since the requisite elements for DEF formation were not present.

A reinforcing steel doweling system was designed to provide mechanical connection between the new and old concrete. This dowel system will provide the required structural capacity without taking credit for the bonding between the old and new concrete. The required depth of embedment to fully develop the dowels was determined by qualification testing (Ref. 10). The holes for dowels will be drilled and dowels grouted at 12" on center, 12" deep, (~3000) on the face of the cold joint to ensure adequate transfer of horizontal shear through the slab section.

The new placements to complete the slab will be in three sections to minimize cracks due to the varying thickness of the placement. The existing concrete surface will be pre-heated to greater than 60°F to promote best possible bond between the old and the new concrete. Extended moist cure times for the new concrete will be used to allow concrete to gain additional tensile strength, preventing accelerated drying and associated shrinkage.

1 Background

Various equipment delays and ambient temperatures over 100°F caused the concrete temperatures to approach the specified maximum of 70 °F (Ref.1) at the point of discharge of the concrete chute. At 9:20AM, the concrete temperature approached the specification limit, Engineering revised the maximum specification limit and directed Construction (Ref 16) to implement mitigating measures and continue placing concrete up to a 75 °F maximum, to eliminate a cold joint. These measures were concentrated fogging at the point of discharge, use of insulating blankets during the curing period, additional monitoring of concrete temperatures during placement and, more frequent cylinder sampling and testing. The 75 °F limit was selected based on thermal data and compressive tests from earlier concrete placements where the concrete temperature exceeded 75° F using the same concrete mixes. The mitigating measures were ultimately ineffective in maintaining the concrete temperatures below 75°F for the balance of the placement. With 1260 cubic yards of placed, the concrete placement operation was taken to a controlled stop at 2:19 PM in accordance with Construction Procedure (Ref. 2) as the concrete temperatures rose above 75 °F. However, no concrete above 75°F was placed in LAW 001. The non-conforming condition was documented in Non Conformance Report (NCR) 02-093 (Ref. 3). A Corrective Action Report (Ref. 4) was issued to investigate the incident and make necessary corrective measures. Subsequent Root Cause Analysis of the incident recommended specific actions to be performed prior to resuming hot weather concrete placements over 36" thickness on the Project.

Representatives from Construction, Engineering, Quality Control and Management performed a Root Cause Analysis (Ref. 5) of the incident and found that the Project accepted the Sub-Contractor's Batch Plant without fully knowing its limitations to support specified hot weather operations. Several causes were identified and corrective actions were recommended. The Project followed the recommendations and resumed concrete placements of over 36" thickness throughout the summer of 2002, successfully.

Engineering personnel visited the site and completed the visual inspection of the non-conforming condition of LAW Facility Placement LAW-001. An interim disposition of NCR 02-093 (Ref 3) was issued to examine and repair the placed concrete. The NCR interim dispositions were used as a vehicle to provide direction to the WTP Construction staff, as follows:

1. An Investigation Phase to determine the condition of the 1,260 cubic yards of placed concrete,
2. An Inspection and Preparation Phase to determine the extent of preparation of Joint required for subsequent placement of Concrete,
3. A Repair Phase providing specific instructions to Construction for installation of a repair system and placement of final concrete for the balance of LAW-001.

A continuous water cure was provided on the cold joint to allow the concrete to reach its full strength. Any suspect concrete at the leading edge of the placed concrete and concrete around partially covered rebar and embeds was removed. The finished portion of the placement was covered with concrete insulating blankets to mitigate the effects of placing concrete at temperature greater than 70 °F.

A pictorial representation of the post-placement condition and placement temperatures are shown in the DNFSB briefing of November 5, 2002 (Ref. 6, Slides 11-14).

2 Investigations

Design Engineering, Field Engineering and Quality Control Personnel monitored the mechanical removal of concrete along the surface of the cold joint area and around partially covered rebar and embeds as described in the Interim NCR disposition. Project Management decided that off-Project expertise was needed to evaluate the condition of placed concrete and ensure adequacy of joint preparation to yield sound concrete. Technical Services of Olson Engineering were acquired to provide their expertise in concrete evaluation. Olson Engineering recommended and performed Non-Destructive Tests (Impact Echo Test and Spectral Analysis of Surface Wave

Tests) on the placed concrete. Initial testing confirmed soundness of concrete in the finished 5 ft thickness and in the North-East and North-West areas of cold joint (Ref. 12). The test results indicated a difference in the soundness in the central area of the cold joint. This anomaly in the NDT results was interpreted by the Consultant as questionable concrete at the surface. The Project continued chipping in the affected area to ensure consistent testing results.

In order to validate field non destructive test data, cores samples for visual inspection and destructive testing of the placed concrete were taken. Olson Engineering selected a total of nine cores (Ref. 6, Slide 19) based on criteria outlined in ACI 318 Section 5.6.5. These sample locations were selected based on the result of the interim non-destructive tests, geometric configuration of the concrete and known location of concrete placed at temperatures in excess of 70° F. Prior to destructive compressive testing of the cylinders, non-destructive tests were performed on the core samples in the laboratory to record velocity readings of concrete with known densities. The cylinders were also visually examined by Olson Engineering and WTP Engineering. The visual examination concluded that the concrete cores represented sound concrete. Twenty nine compressive test cylinders were prepared from the nine core samples. Destructive tests in accordance with ASTM C42 were performed to determine compressive strength (Ref. 7). All 29 of the destructive tests performed on the cores exceeded the design specified 4000 psi. The compressive strength of the test cylinders ranged from 4030 psi to 6130 psi.

After Construction chipped the surface of the central section, where inconsistent data was obtained by Olson Engineering, a final non-destructive check of the entire placement was performed. The tests were performed in accordance with WTP Construction Special Instruction (Ref 17) at a frequency of one test every 2 square feet in the cold joint area and one test every 4 square feet in the finished areas of the placement. Over 1400 tests were performed and the test results concluded that the concrete was good material and deemed "sound" (Ref. 14).

3 Cold Joint Preparation and Inspection

Bechtel sub-Contractor for Steam Generator Replacement Project at Davis-Bessie Nuclear Station reviewed the feasibility of removing the concrete in the area of the cold joint by hydro-demolition, and concluded that this method was impractical. The hydro demolition process was slow, unsafe, costly and unnecessary. Construction was instructed to mechanically remove concrete to create vertical interfaces to the extent possible and reach sound concrete. The leading edges of the sloping surface were chipped back to a create a minimum 20 inch vertical surface. The 20 inch dimension provides adequate thickness to install the reinforcing steel dowels. Pictorial representation of this contour is depicted in slide 13 of DNFSB staff briefing (Ref. 6). The sloping surface of the placement was visually inspected (Ref. 13) after mechanical concrete removal and roughing, using the criteria listed in Table 1. This joint preparation promotes good adhesion between old concrete placement and new placement.

Table 1: Joint Preparation, Visual Inspection Criteria

No	Condition/Concern	Analysis/Test/Inspection Requirements	Acceptance Criteria
1	Smooth Shiny surfaces	Visual inspection following Mechanical roughing of surface to assure adhesion between old and new placement.	No shiny surfaces. The surface to be mechanically roughed up to provide for 1/4" surface amplitude.
2	Films or oily spots	Visual inspection following pressure blasting and Mechanical roughing of surface to ensure adhesion between old and new placement	No films or oily spots.
3	Loose rock or sand	Clean and remove from surface and visually inspect to ensure adhesion between old and new placement	No loose rocks or sand
4	Inconsistent color, large areas of different color.	Visual inspection following pressure blasting and Mechanical roughing of surface to ensure adhesion between old and new placement	Consistent surface condition and color.
5	Visible cracking (except shrinkage cracks)	Mechanically remove material to sound cracked concrete and visually inspect after removal.	No measurable cracks.

The Concrete Batch Plant reports for the day of the LAW-001 placement and thermal data from subsequent large placements of similar volume, concrete mix, and climatic conditions were analyzed to ensure acceptability of the greater than 70°F concrete. A concrete specialist (Mr. Gary Mass, a Fellow of the American Concrete Institute) was engaged to assess the out-of-specification concrete quality. MWH/Gary Mass Report dated October 29 2002 (Ref 8) and thermal analysis per United States Army Corps of Engineers procedure ETL-1110-2-542 found the placement to be acceptable. Table 2 summarizes the acceptance criteria used to verify the concrete soundness related to thermal considerations.

Table 2: Soundness of >70°F Concrete

No	Condition/Concern	Analysis/Test/Inspection Requirements	Acceptance Criteria	Results
1	Thermal Cracking	Visual Inspection	Placed Concrete does not indicate thermal cracks	No thermal cracks were found on the placed slab.
2	Water Demand	Compare water usage at the batch plant for the mixes below and above 70 °F	Water usage at the higher temperature is typically higher	Water demand for >70°F concrete was actually lower than <70°F. This is acceptable.
3	Thermal Loads	Thermal analysis for the placement to calculate average placement temperature, post-placement temperature rise and calculation of tensile strength	Thermal/tensile stress < 474 psi	The calculated effective placement temperature was 75 °F and 79 °F. The calculated peak concrete internal temperatures post placement were 151°F and 116 °F. The calculated thermal stress was 299 psi, which is acceptable.
4	Consolidation	Perform Impact Echo tests on the cold joint in a defined grid pattern in the affected area. Extract Core bores on placed concrete in the locations where >70° F concrete was placed. Visual examination of the core and the bore holes in the concrete to confirm consolidation and absence of unacceptable voids. Compression tests for the core samples from the cold joint	The Impact Echo tests should show that we have the required thickness of concrete and the Impact Echo velocity is with in 5% from the mean. No friable materials. Consolidated concrete. Compression tests > 4000 psi	Core bores were performed at 7 locations where concrete was placed over 70° F. In addition to visual inspection of the cores, Impact Echo tests on a defined grid were performed with acceptable results. The external surfaces of the cores and the internal surfaces of the core bores were examined by Ultrasonic Pulse Velocity tests and found acceptable. All destructive test results were >4000 psi.

4 Analysis and Repair

After the initial investigation and analysis were completed, engineering developed and finalized the repair procedure of the cold joint. It was determined that grouting reinforcing steel dowels into the existing concrete surface would be the best means to tie the existing concrete to the new concrete placements. The initial design thickness of the basemat was determined to preclude the use of shear reinforcement in the slab. Engineering performed a calculation (Ref 9) to size the doweling system necessary to provide adequate shear friction across the interface. The shear friction criteria identified in ACI 318 Section 11.7 was followed to achieve the required cold joint conditions ensuring a sound structure after repairs are made. Conservatively, no reliance on bonding between the new and old concrete was assumed in the design of the repair. It was determined that number 5 reinforcing steel dowels placed on twelve inch centers each way replaced the concrete shear capacity at the cold joint.

In order to ensure proper performance of the reinforcing steel dowels, qualification testing of the dowels was performed in accordance with ASTM 488 and ACI 355 Appendix A, A1.4. The required depth of anchorage into the concrete to ensure full development of the dowel was ascertained and verified by qualification testing. This information was used by Engineering to specify the required dowel embedment depth.

The grout selected to anchor the # 5 rebar selected was Masterflow 928 (Ref. 15). This grout is stable at high service temperature conditions anticipated for the Facility. A 30' x 30'x 2' test slab of the specified concrete mix (F4; 1-1/2" aggregate and F5- 3/4" aggregate reaching 4000 psi min. compressive strength at 28 day cure) with representative reinforcement was placed at site. This slab was used to test the engineered repair system in accordance with ASTM 488 and ACI 355 Appendix A, A1.4 and the grout manufacturer's recommendations. Services of an independent qualified consultant were acquired to test the repair system to the acceptance criteria described in Table 3. CEL Consulting Report of Reinforcing Steel Dowel Testing dated October 25, 2002 (Ref. 10) provided the qualification test report for dowels.

Table 3: Concrete Shear capacity in the region of the Cold Joint

No	Condition/Concern	Analysis/Test/Inspection Requirements	Acceptance Criteria	Results
1	Design analysis assumes monolithic section. The concern relates to reduced shear capacity at joint interface.	Review original design and analyses impact of joint. Design the cold joint interface with a dowel arrangement that will equal the un-reinforced shear capacity of the base mat.	The dowel arrangement will sustain the design shear loads with out taking credit for adhesion of the old and new concrete placement. The qualification of the dowels will be per ASTM 488.	The dowel design was qualified by testing on a 30ft x 30ft x 2 ft slab. Testing was overseen and certified by a qualified consultant, CEL. The tested dowel design will be used in the design of the dowel layout for the cold joint.

The existing concrete surface will be left in a roughened and sound state to accept the concrete placements. Measures (see Section 6) including heating the old concrete to a temperature of approximately 60°F will be taken during the preparation and placement of the concrete to obtain the best possible bond.

The embedments located in the area of the cold joint were reviewed to determine the adequacy of the embedments to perform as required for equipment anchorage. Engineering calculation (Ref. 11) shows that the embed plates in the vicinity of the cold joint have adequate design margin.

5 Engineered Joint Concrete Placement

The final concrete placements will consist of a total of approximately 400 cubic yards and are designated as LAW 1B, 1C and 1D as shown in Exhibit A of NCR 02-093 (Ref. 3). The construction joints will be constructed using Stay-Form material, the same as all other construction joints in the LAW basemat. Concrete placement will proceed following BNI Engineering review and approval of final soundness check by Non-Destructive Test Consultant

(Ref 14) and release for placement by DOE. The cold joint will be prepared to ensure a sound concrete structure is achieved.

Prior to final concrete placement, the surface will be cleaned and inspected to ensure all loose material is removed and the surface is acceptable (Ref 13). Criteria for surface acceptability is detailed in NCR 02-093 (Ref 3). Construction joints shall be located to minimize the possibility of differential shrinkage due to variable concrete thicknesses over the cold joint. Construction joint locations are shown in Exhibit A of NCR 02-093 (Ref 3).

Prior to concrete placement, the existing concrete surface will be heated to achieve an approximate concrete surface temperature of 60 °F. The concrete surface will be kept moist for a minimum of 12 hours prior to concrete placement. The heating and surface saturation is done to obtain the best possible bond between the new and old concrete.
The concrete mixes placed over the cold joint will be the same mixes as the existing concrete. The aggregate size will be selected to ensure the desired workability and consolidation of the concrete.

Water curing of the concrete placed over the cold joint area will be required. The water curing period will be extended beyond the normal period of 7 days to 21 days to allow the concrete to gain additional tensile strength on the surface before exposing it to drying. During the curing period, the concrete will be insulated to minimize the thermal differential between the middle of the concrete mass and the outside surface.

6 Conclusions

The Root Cause Evaluation identified the inadequacy of the concrete batch plant to provide 70 °F concrete at the ambient temperature exceeding 95°F. This resulted in administrative controls on placing concrete during high ambient for slabs thicker than 36 inches. Careful planning and extensive communications were employed between the Batch Plant personnel and Construction personnel prior to and during placements so as to respond to any changing conditions at the placement site and delivery systems.

Consultants/Specialists and BNI Engineering reviews of the placed concrete, indicate all LAW 001 concrete (including > 70°F concrete) meets the project requirements, is of good quality, and is capable of providing long-term performance and serviceability. The utilization of reinforcing steel dowels will provide the required design capacity without taking into account bonding between the old and the new concrete and construction aid steel. The requirement to have the old concrete at the cold joint to be higher than 60 °F prior to the pour provides the best possible bond between old and new concrete. Extended moist cure times for the new placements allows concrete to gain additional tensile strength, preventing accelerated drying and associated shrinkage.

The concrete slab resulting from the placements of pour 1 and the added pours 1B, 1C, 1D will have the structural capability and durability required by the original design.

7 References

1. 24590-WTP-3PS-D000-T0001 Engineering Specification for Concrete Work

2. 24590-WTP-GPP-CON-3203 Concrete Operations (Including Supply)

3. 24590-WTP-NCR-CON-02-093 Non Conformance Report

4. 24590-WTP-CAR-QA-02-139 Corrective Action Report

5. 24590-LAW-RPT-CON-02-001 Root Cause Analysis

6. Briefing to Defense Nuclear Facilities Safety Board on the Low Activity Waste Facility (LAW) Cold Joint dated November 5, 2002 (Slides)

7. 24590-CM-HC3-CY10-0001-03-01, LAW Concrete Placement, South East Slab, Cold Joint-Core Test Program Results

8. MWH Energy & Infrastructure Inc, Report (October 29,2002)

9. 24590-LAW-SOC-515T-00011, Engineering Calculation

10. CEL Report of Reinforcing Steel Dowel Testing (October 25, 2002)

11. 24590-LAW-DDC-S13T-00018 Engineering Calculation

12. Olson Report October 14, 2002, Interim Concrete Condition Assessment

13. Cold Joint Preparation Inspection Sheets

14. Final Olson Engineering Report (December 11, 2002)

15. Masterflow 928 Manufacturer's data

16. 24590-WTP-NCR-CON-02-092 Non Conformance Report

17. 24590-LAW-SI-C-02-009 Special Instruction, Final Impact Echo Testing

Bechtel Systems
&
Infrastructure, Inc.

JOB No. ________________

SUPPLIER DOCUMENT STATUS	
1. ☒	WORK MAY PROCEED
2. ☐	REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO RESOLUTION OF INDICATED COMMENTS
3. ☐	REVISE AND RESUBMIT. WORK MAY NOT PROCEED
4. ☐	REVIEW NOT REQUIRED. WORK MAY PROCEED.

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G-321 DOCUMENT CATEGORY ________________
[From Supplement A to G-321-E (E) or G-321-V (V), as applicable]
RESPONSIBLE ENGINEER [signature] DATE 12-17-02

24590-CM-HC4-CY05-00001-05-01
REV. 00A

SUBCONTRACT SUBMITTAL

OLSON ENGINEERING, INC.

Condition Evaluation of the Civil Infrastructure
Specializing in Nondestructive Technologies

RPP-WTP
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DEC 16 2002
BY PDC

FINAL CONCRETE CONDITION ASSESSMENT REPORT
SOUTHEAST FOUNDATION SLAB COLD JOINT EVALUATION
LOW ACTIVITY WASTE STRUCTURE
DOE HANFORD WASTE VITRIFICATION PROJECT
HANFORD, WASHINGTON

Prepared for:

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Olson Engineering Job No. 1255

December 11, 2002

24590-CM-HC4-CY05-00051-05-01
REV. 00A

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TABLE OF CONTENTS

1.0 INTRODUCTION

Olson Engineering was contracted by Bechtel National, Inc. (BECHTEL) to perform a concrete condition assessment investigation on the southeast concrete foundation slab of the Low Activity Waste (LAW) vitrification facility at the Department of Energy (DOE) Hanford Site located in Hanford, Washington. This investigation was performed to evaluate the integrity and strength of the LAW southeast concrete slab. We understand that during the placement on July 11, 2002, the temperature of the concrete exceeded the specified maximum acceptable level of 70 degree F and that BECHTEL stopped the placement as temperature exceeded 75 degrees F. Thus, about 1200 of 1660 cubic yards of concrete was placed in the 5 ft thick southeast slab area. This resulted in a sloping concrete cold joint along the north. Mr. Ray Raparelli, P.E. of Olson Engineering, Inc., performed the investigation from November 18 through the 23rd, 2002, with assistance from BECHTEL personnel.

The slab thus was 5 ft thick from the south and had nominally 4 ft and 2 ft thick areas going north as a result of the 2 ft lifts used in placement which started from the south and went north. BECHTEL began a program in the summer to remove any questionable quality concrete from the leading edges and surfaces of cold joint areas by chipping with small jackhammers. The purpose of this investigation was broken down into three tasks as follows:

Task 1- Nondestructively assess the conditions of full thickness and sloping concrete areas to identify any areas of remaining questionable quality concrete after much of the chipping had been done;

Task 2 - Obtain core samples of the concrete for laboratory tests including strength, density and ultrasonic pulse velocity to evaluate the quality of the structural concrete material; and,

Task 3 - Nondestructively check the entire slab for any remaining areas of questionable quality concrete with the Impact Echo method after chipping operations were completed and prior to planned repairs by BECHTEL.

The results of the initial nondestructive evaluation (NDE) investigation were reported in our Interim Report of October 14, 2002 and are not repeated herein except as discussed in the Summary and Conclusions section below and briefly reviewed in Section 3. The results of the laboratory tests of the cores were first reported in our report of November 4, 2002 and are discussed again herein as they are pertinent to the decision by BECHTEL to accept or reject the slab for as being suitable for repairs. Finally, the results of nondestructive Impact Echo results conducted to check for any remaining questionable concrete and confirm only good quality concrete remains are reported herein (these tests were conducted after additional chipping was done to remove near-surface questionable concrete identified in the initial NDE). The results of Tasks 2 and 3 are presented in the remainder of this report below.

2.0 SUMMARY AND CONCLUSIONS

Task 1 - Initial NDE Results

1. NDE Program. Impact Echo (IE) tests were used on a nominal 10 ft grid on full thickness and cold joint areas to identify areas with thickness echoes indicative of good quality concrete and areas of questionable quality concrete. In some cold joint areas, no echoes were identified in IE test results due to near-surface questionable quality concrete conditions. Limited Spectral Analysis of Surface Wave (SASW) tests confirmed the existence of near-surface questionable quality concrete in the cold joint.

2. NDE Results. The initial NDE identified areas of near-surface questionable quality concrete in the north-central areas of the cold joint with good quality concrete conditions found in east and west slab areas of the cold joint (see Fig. 1). The NDE results showed only good quality concrete at test locations in the 5-ft full thickness south slab area.

3. Observations of Exposed Concrete and Chipping Operations. Visual observations of the fully exposed south and west perimeters of the slab in late September and October, 2002 did not reveal any areas of significant void or honeycomb or cold joints. Further observations of the full 5 ft thickness and sloping cold joint also did not show ares of visible void and honeycomb. However, observations of the continuing chipping operations by OLSON and BECHTEL personnel showed that up to 3 inches of questionable quality concrete existed that was readily removed by chipping to expose good quality concrete in the north-central areas of the cold joint as predicted by the NDE results.

Task 2 - Core Test Results

1. Core Drilling Program. A total of 9 - 3.66 inch diameter cores were drilled for BECHTEL from the slab surface to within a few inches of the bottom mat of reinforcing steel at the locations shown in Figure 7. Five of the core locations were selected in the north-central cold joint area where NDE results identified questionable quality concrete. Two cores were obtained from the apparent good quality concrete of the east and west cold joint areas. In the full 5-ft thick section area, a core was taken from near the south edge of the cold joint where concrete temperatures had increased and the final core was taken from near the south edge of the slab where concrete temperatures were below the specified 70 degree F limit. The cores were thus located from south to north to check for any degradation in compressive strength and internal thermal cracking as a result of the increasing temperature of concrete. The cores were also located to sample areas of apparent questionable quality and good quality concrete in the cold joint. As no evidence of void or honeycomb was visible below the bottom reinforcing steel along the chipped out north edge of the cold joint, the cores were not extended through the slab in order to avoid cutting the steel. The initial Impact Echo results also did not indicate the presence of significant honeycomb/void below the bottom mat of steel (where thickness echoes were obtained in cold joint areas).

2. Core Compressive Strengths. Core compressive strengths on 29 core specimens from the 9 core samples ranged from 4,030 to 6,130 psi and averaged 5,242 psi with a standard deviation of 602 psi as shown in Table I. All core compressive strength values exceeded the design strength requirement of $f'_c = 4,000$ psi which was specified for the LAW slab concrete. Furthermore, the core strength results easily meet the American Concrete Instititute ACI 318-5.6.5 criteria for accepting concrete strength based on core compressive strength results of the average strength being at least $0.85\ f'_c$ and no single core being less than $0.75\ f'_c$. It should be noted that the lowest measured strength was within within 2 standard deviations of the mean strength.

3. Core Unit Weights. After trimming of core specimens, unit weights ranged from 149.5 to 155.3 pcf and averaged 152.1 pcf (see Table I). These results are indicative of normally consolidated concrete.

4. Core Ultrasonic Pulse Velocities. Pulse Velocities ranged from 13,800 fps to 15,800 fps with an average velocity of 15,000 fps and a standard deviation of 600 fps (see Table I). Thus, like the strength results, the slowest pulse velocity was within 2 standard deviations of the mean pulse velocity.

5. Core Observations. Observations of the cores did not show any significant voids or questionable quality concrete zones. Only small, isolated voids were observed that are typical of normal, good quality structural concrete (see Table II). The unit weight values also support this observation. However, as discussed above, chipping operations revealed a near-surface zone of questionable quality concrete. It is expected that the lack of identifiable questionable quality concrete at the tops of the cores is due to the fact that the chipping had removed most of the questionable quality concrete prior to the cores being obtained. Furthermore, trimming of the cores for strength tests would have resulted in more of the near-surface concrete being removed from the cold joint cores. Finally, any remaining questionable concrete would have been comparatively thin and confined by the end platens in compressive strength tests which minimizes the effect of a questionable quality concrete zone at a core end.

Task 3 - Final NDE Results

1. Final NDE Program. The final NDT program was conducted under a plan developed to meet BECHTEL's NQA-1 nuclear quality assurance program and is detailed herein. To summarize, the plan involved a daily calibration procedure for the Impact Echo test equipment, measurement of IE velocity from the visibly sound concrete around the south

and west perimeters of the southeast slab, use of an Impact Echo velocity tolerance based on the strength and pulse velocity results showing acceptable results within 2 standard deviations of the mean, and Impact Echo test grids of 2 ft square throughout the cold joint (approximates the minimum existing thickness) and 4 ft square in the full 5 ft thick area, and evaluation of the IE thickness echo results to determine if the expected thickness echo was obtained within the velocity/depth tolerance which would indicate a "pass" rating indicative of good quality concrete. If such an echo was not obtained, then the test location would be considered to have a "fail" rating indicative of questionable quality concrete and additional chipping/coring/NDE would be performed until only sound concrete remained.

2. Impact Echo Velocity Measurements from Sound Slab Perimeter. The Impact Echo velocity measured from 35 tests around the sound slab perimeter showed a velocity of 12,219 fps with a standard deviation of 621 fps (see Table IA in Appendix A). At some locations the IE tests showed echoes indicative of the 4 inch thick mud mat (also 4,000 psi concrete - 3/4 inch mix design like the top 1 ft of the slab) plus the exposed slab thickness which indicated tight contact between the slab and mud slab. Analysis of this data resulted in a tolerance of ±10 percent being used to evaluate thickness echo results from the slab interior on a pass/fail basis.

3. Final Impact Echo Results. As shown in Table IB and Figure A-1 in Appendix A, all locations tests produced Impact Echo results indicative of good quality concrete within a depth tolerance of ±10 percent. Thus, echoes were measured indicative of the slab thickness or slab plus 4 inch mud mat thickness accounting for the actual elevation of the cold joint or full 5-ft slab section at the test locations. The IE results thus confirmed that the final chipping operations successfully removed near-surface questionable quality concrete from cold joint areas to expose only good quality concrete at the surface and interior of the slab.

4. <u>Discussion of Near-Surface Questionable Quality Cold Joint Concrete.</u> We believe that the zone of questionable quality concrete predicted by NDE and confirmed by chipping operations as discussed above is due to the difficulties of consolidating concrete when it is comparatively unconfined. In otherwords, on the sloping surface of an interrupted concrete placement, the use of vibrators in a normal fashion will result in the concrete moving downhill because it is not confined ultimately by formwork. Thus, with the resultant use of shorter vibration times the near-surface concrete zone may not flow away but is not as well-confined as deeper concrete and is consequently not as well-consolidated. Poorer consolidation results in weaker, less dense concrete. In our opinion, this is what occurred at leading edges of the placement and the near-surface zone of the cold joint concrete.

3.0 INVESTIGATION OVERVIEW

As discussed in the Introduction, the purpose of this investigation was to perform a concrete condition assessment on the SE concrete slab at the LAW facility located at the DOE Hanford site in Hanford, Washington.

3.1 Task 1 - Initial NDE of Slab Testing Program

The conditions of the slab were visually observed by Messrs. Larry Olson and Ray Raparelli of Olson Engineering, Inc. along with Bechtel National, Inc. personnel on the afternoon of September 23, 2002. This investigation was requested due to concerns over poorly consolidated and potentially weaker concrete in the north, leading edge of the placement. Based on a briefing in an initial meeting of Mr. Olson with Messrs. Don Scribner, Mark Braccia and Pete Labarta of Bechtel, we understand that the placement was stopped prior to its completion due to the occurrence of rising temperatures in the batch-plant concrete exceeding 75 degrees F on July 11, 2002.

As a result of the meeting and visual observations of the SE slab, it was decided to use the Impact Echo (IE) method to evaluate the internal conditions of the concrete. The IE method requires access to only one the top side of the slab. The IE method is a thickness/flaw resonant sound wave reflection test that was used to measure the overall thickness of the concrete slab and check for internal areas of possible cold joints and questionable consolidation. Mr. Raparelli performed the IE tests across the SE slab on September 24-26 with the assistance of Bechtel personnel. Bechtel Field Engineers created 45 test zones throughout the questionable area of the slab. The layout of the test zones are shown in Fig. 1. At least two IE tests were performed in each zone on a nominal 10 ft grid.

Impact Echo (IE) results in the 5 ft thick slab area consistently had echoes that predicted the full thickness of the slab using a compressional (sound) wave velocity indicative of good quality concrete. The IE thickness echoes were often absent and the tests inconclusive in the south (central) chip-out area in Figure 1 which indicates the weak surface concrete extended deeper. In the north chip-out area, IE showed some positive thickness results, suggesting the weak concrete is shallower and limited to the near-surface zone of the concrete. In the chipped-out areas directly west and east of the north chipping area, the IE results showed good quality concrete.

Initial NDE testing was conducted September 24-26, 2002 by Mr. Raparelli with assistance of Bechtel personnel to determine where additional chipping would be required to remove all questionable quality concrete. The NDE utilized included the Impact Echo (IE) test method with an Olson Instruments Concrete Thickness Gauge (Model CTG-1TF). Initial NDE results found good quality concrete in the full-thickness sections of the 5 ft thick slab at the south end. The Impact Echo (IE) tests predicted nominally a 5 ft thick slab with a sound (compressional) wave velocity indicative of good quality concrete. Similar good IE thickness (adjusted for concrete removal) and Spectral Analysis of Surface Wave (SASW) velocity results were found in east and west portions of the sloping cold joint slab that indicate the remaining concrete is of good quality. However, areas of near-surface poor quality, weak concrete still remained in the north-central portions of the slab. In these areas, IE tests did not always result in a thickness echo due to questionable quality, weak concrete at the surface. Additional chipping was subsequently performed by Bechtel in the cold joint areas to depths of up to 3 inches. The locations and conservative estimated maximum depths of chipping can be found in Fig. 1 below.

3.2 Task 2 - Core Test Program

Cores were obtained from 9 locations for laboratory strength, density and velocity tests to compare good to questionable concrete conditions and to correlate NDE and destructive results prior to full removal of questionable quality concrete. The results of the core testing can be found in Section 5.0 of this report. Further IE tests were to be conducted on the concrete after further chip-out and removal of questionable quality concrete was done to confirm that the remaining concrete is of good quality.

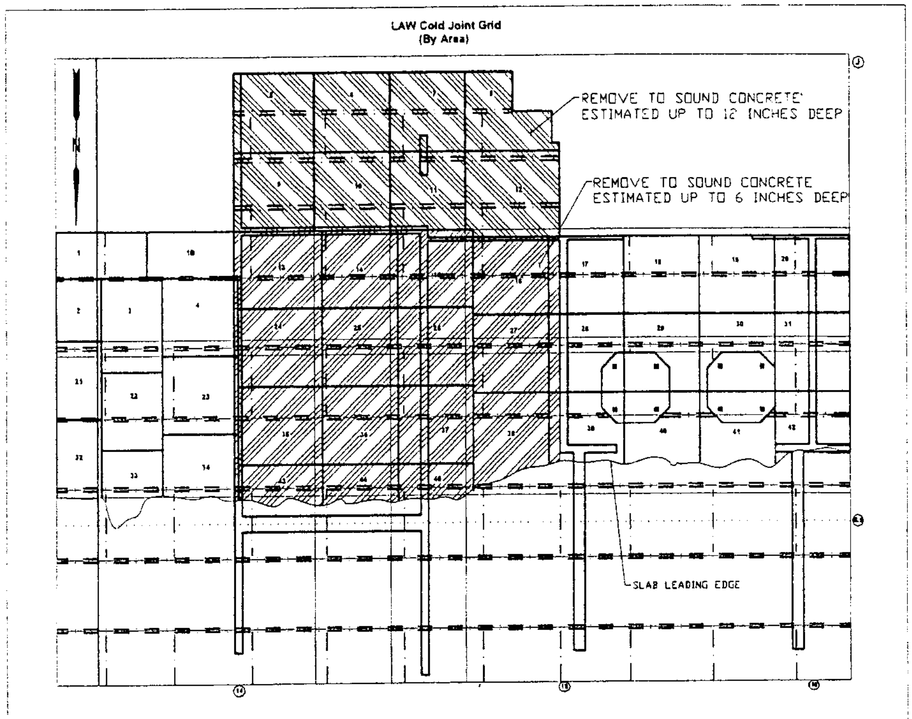

Figure 1 - Areas of additional chipping after initial NDT results

3.3 Task 3 - Final Field NDE Plan

The Final NDT Plan discusses the procedures followed for nondestructive evaluation (NDE) of the remaining concrete after chipping to check its soundness prior to repairs proposed for the southeast LAW slab. Olson Engineering, Inc. conducted final NDE of the slab with the Impact Echo method to confirm the remaining concrete is sound and of good quality for Bechtel. This plan is detailed below and was done under Bechtel's NQA-1 program.

1. Impact Echo Gauge Calibration. Calibrate the CTG-1TF Impact Echo gauge per Olson Instruments instructions. Verify CTG calibration on Aluminum 6x12 test cylinder once every 5 hours of testing.

2. SE LAW slab concrete IE velocity determination. The IE velocity to be used during the final NDT testing of the slab will be determined by performing IE tests at 4 ft intervals along the visibly sound perimeter of the slab, at locations in which the full thickness of the slab is accessible and can be measured directly plus the 4 inch thick mud mat (which is the same mix ¾ inch-4000 psi mix design as the top 1 ft of the slab - the bottom 4 ft of the slab is a 1 ½ inch-4000 psi mix). The average velocity from these perimeter tests of known thickness and visibly sound conditions will be used as the IE velocity during the final NDT testing.

3. Impact Echo Thickness/Velocity Tolerance. The tolerance value, i.e., acceptable variation of Impact Echo thickness/velocity will be based on our past experience as well as the standard deviation of the results of the IE tests around the perimeter of the slab. The standard deviation of the core compressive strength results is 602 psi from a mean value of 5,242 psi, or a coefficient of variation of 11.5%. The standard deviation of the ultrasonic pulse velocity is 600 fps from a mean value of 15,000 fps, or a coefficient of variation of 4.0%. These results show acceptable strength conditions within minus two standard deviations of the mean, with no values falling below the acceptable compressive strength of

4,000 psi or normal concrete velocities for good quality concrete. We expect the variation in velocities IE thickness echo results around the sound slab perimeter to be in a similar range of 5 to 10%, which corresponds to the variation of acceptable values found in the core test program and is also within the typical range of variation found during our past experience using this method. The criteria for our final analysis of the IE data will be based on a similar statistical analysis. The laboratory core test results data was taken from the Olson Engineering report entitled "Core Test Program Results", dated November 12, 2002.

4. Impact Echo Test Grids. The SE slab will then be divided into approximately 4 ft square test sections in the full 5 ft finished areas, and 2 ft square test sections in the chipped out portion of the slab for IE testing. Bechtel will provide a 4x4 ft layout of the test grid throughout the entire slab. These test grids are based on the minimum thickness of the slab in the test areas. By assuming the test grid is roughly equal to or less than the minimum thickness of the slab, sufficient NDT coverage is provided. The distance below the top of the finished slab will be measured and recorded in cold joint areas so the remaining slab thickness is known at each NDT location.

5. Field Impact Echo Test and Evaluation Criteria. Exact test locations within each test area will be determined in the field based on access and existing surface condition, and the surface will be prepared as required. Two records will be recorded at each test location using a CTG-1TF. If the measured thickness of the slab matches the expected slab thickness within an excepted tolerance, the location will be given a "Pass" rating, if no response can be generated or the thickness reading is either greater than or less than the expected value by a statistically significant value, the location will be given a "Fail" rating. If the apparent reason for the Fail rating is near-surface questionable quality or otherwise damaged concrete, then Bechtel will chip out the concrete to sound concrete prior to performing IE re-tests. At locations receiving a Fail condition rating after re-chipping and IE re-tests, coring and laboratory testing will be performed at the test location. Should IE and core results indicate

A

a deeper questionable concrete area, such concrete will be removed by chipping to sound concrete or the mud mat is exposed.

6. Impact Echo Data Form. The attached data sheet will be used to record the test location, field measurements, file numbers, CTG-1TF settings and any applicable field notes. Each test location will also be assigned an initial Pass or Fail condition rating based on an initial field analysis of the test results.

Mr. Ray Raparelli, P.E. of Olson Engineering, Inc., performed the investigation from November 18 through the 23rd, 2002, with assistance from BECHTEL personnel.

4.0 IMPACT ECHO (IE) METHOD AND RESULTS

The Impact Echo (IE) method was used in this investigation to characterize the concrete throughout the entire slab. The IE method description, field technique, and example data are given below.

4.1 Impact Echo (IE) Test Method and Collection of Data

The IE method was performed during this investigation using our Olson Instruments Concrete Thickness Gauge (Model CTG-1TF). The CTG is a nondestructive, battery powered, handheld instrument for measuring the thickness and integrity of concrete slabs, pavements, tunnel linings, walls and other plate-like structures. The IE tests performed in this investigation involved impacting the concrete slab with a small solenoid operated impactor or small hammer and identifying the reflected wave energy with a displacement transducer (Fig 3).

After the sound wave is generated by the solenoid source, the resonant echoes are recorded by the displacement transducer of the CTG. The resonant echoes of the displacement responses are usually not apparent in the time domain, but are more easily identified in the frequency domain. Consequently, the linear frequency spectra of the displacement responses are calculated by performing a Fast Fourier transform (FFT) analysis to determine the resonant echo peak(s). The relationship among the resonant echo depth frequency peak (f), the compressional wave velocity (V_P) and the echo depth (D) is expressed in the following equation:

$$D = \beta V_p/(2*f) \quad (1)$$

where β is a factor equal to 0.96 for a slab/wall shape. In this investigation, the IE velocity was determined from measurements around the visibly sound south and west slab perimeter. Tests were conducted at 35 location, resulting in a mean of 12, 210 fps. This standard deviation of this data was 621, with a maximum and minimum of 13,347 fps and 11,349, respectively.

The IE method can be used for measuring concrete thicknesses, evaluating concrete quality, and detecting hidden flaws such as cracks, honeycombs, etc. The IE test data was recorded on the

CTG (shown in Fig. 3) during the field NDT&E and later downloaded to a computer for post-processing. The CTG can store up to 300 records.

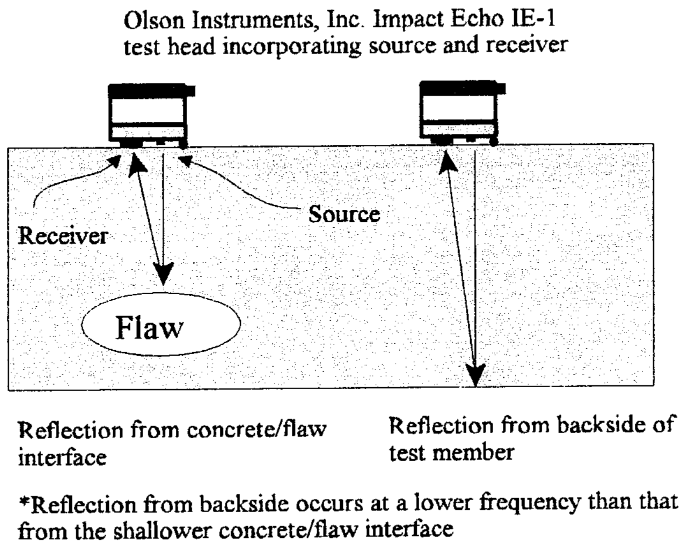

Figure 2 - Schematic of IE Method

Figure 3 - CTG-1TF during IE Testing

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4.2 Impact Echo (IE) Example Data

Figure 4 shows example data recorded on the CTG during an IE test at point D42. The top plot shows transducer displacement versus time. The second plot is the spectra of the data and shows the frequency domain thickness peak at 58.9 inches (echo frequency of 1245 Hz). The expected thickness of the slab was 60 inches. The IE velocity used during testing was 12,219 fps or 146,628 inches per second.

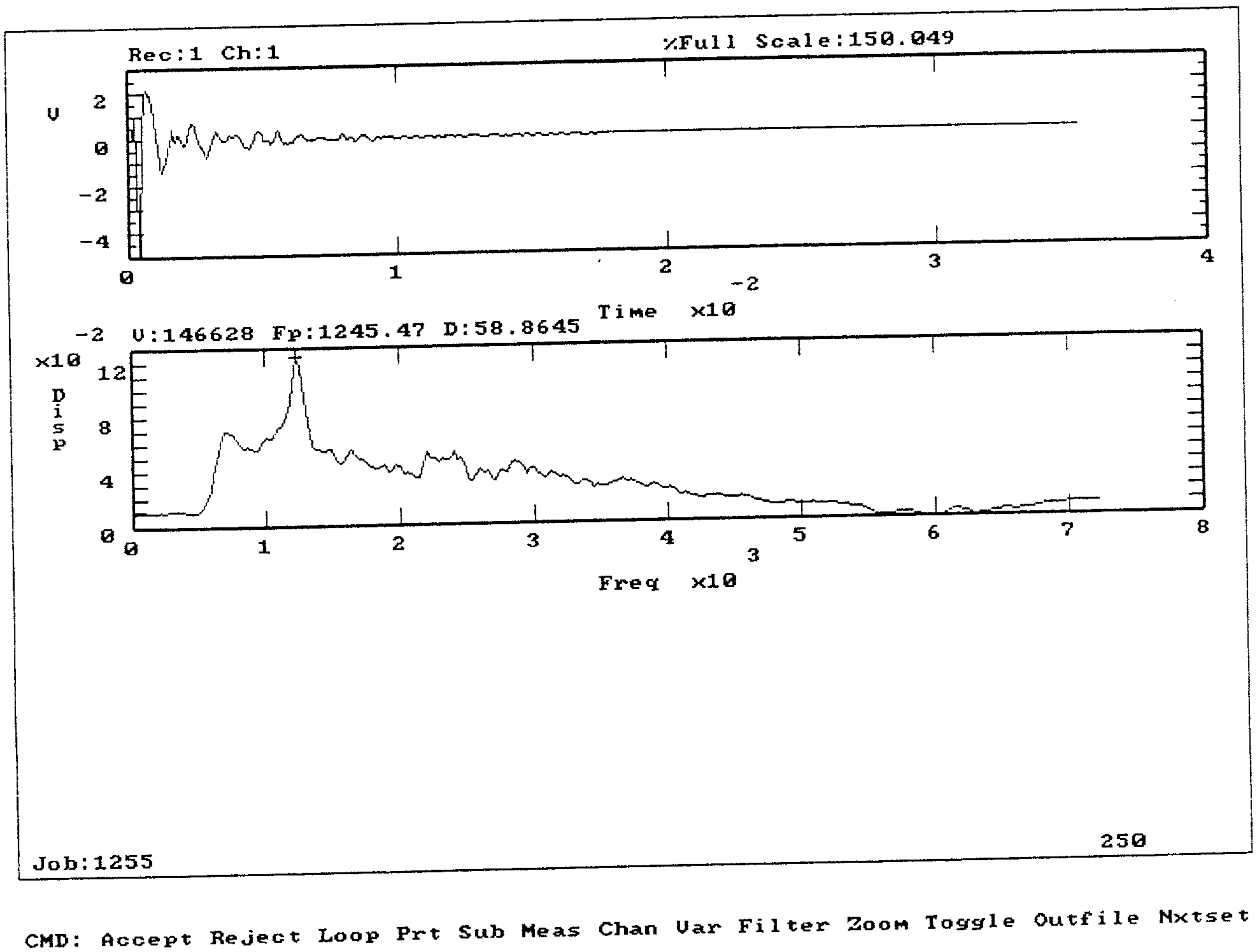


Figure 4 - Full Thickness IE test at test location D42

Figure 5 shows example data recorded on the CTG during an IE test at point Y45 in the chipped portion of the slab. The top plot shows transducer displacement versus time. The second plot is the spectra of the data and shows the frequency domain thickness peak at 29.1 inches (echo frequency of 2519 Hz). The expected thickness of the slab was 25 to 29 inches in this area of the cold joint.

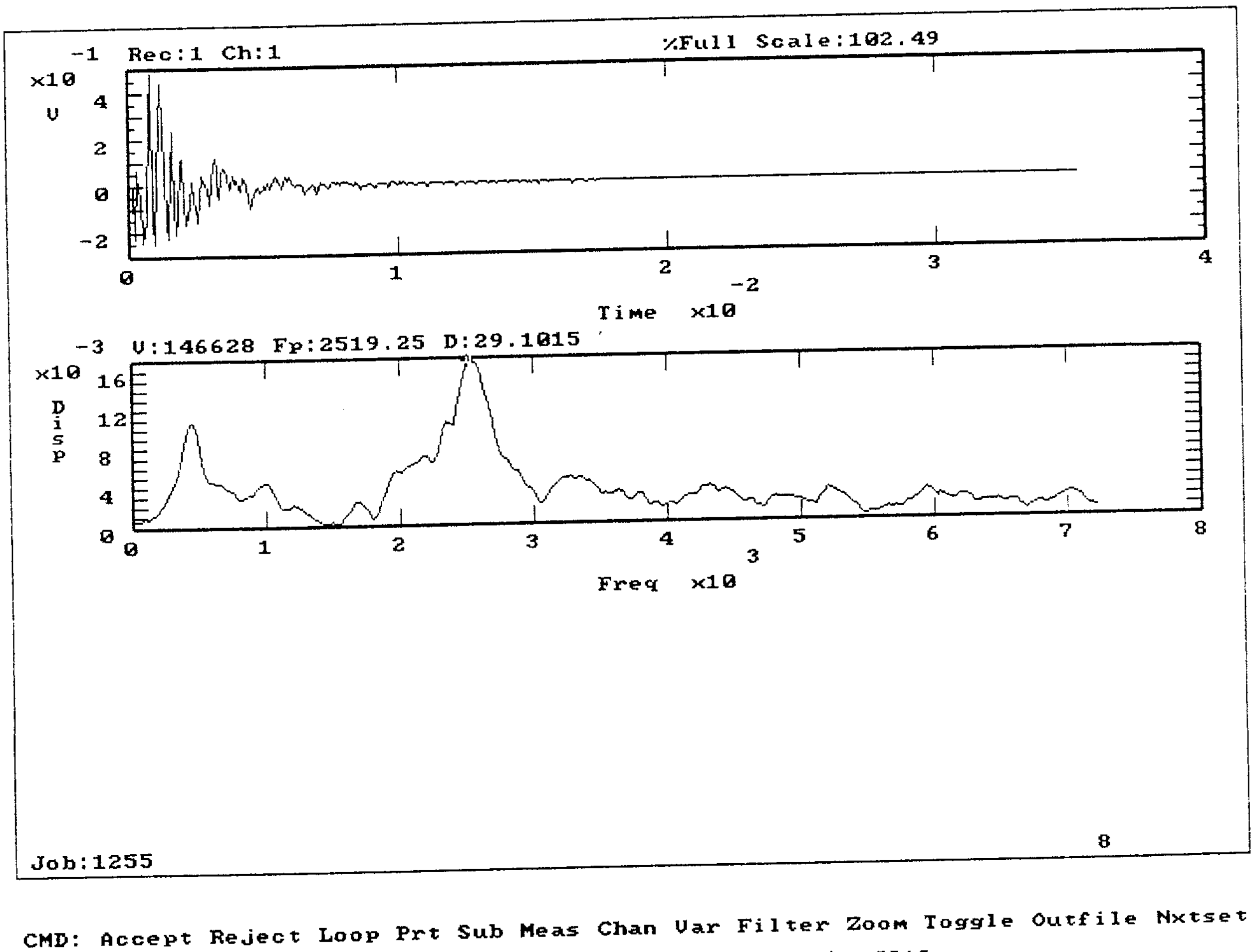


Figure 5 - Partial Thickness IE test in the cold joint at test location Y45

4.3 CTG-1TF Calibration Procedure

The following procedure was followed by Bellhaven Laboratories in Kennewick, WA in to check the calibration of the CTG-1TF used during the investigation.

Calibration Procedure

1. Place CTG-1TF on end of Aluminum test cylinder such that solenoid impactor impacts the test specimen at the center point.
2. Under the thickness calibration function on the CTG-1TF, enter a thickness value of 12.0 inches and fire solenoid.
3. CTG-1TF should read a velocity value within 1% of 16,600 fps (± 166 fps or 16,434 to 16,766 fps).

Cylinder Properties:

AL 6 inch diameter (± 0.022 inches) x 12" length

S/N: 0001 Length = 12.000 inches ± 0.002 inches

Alumininum Type - ALUM 6061 T6511

Cylinder IE Velocity Measurement:

Impact Echo testing was done in the Olson Instruments laboratory using a manufacturer calibrated PC based digital data acquisition system by National Instruments, Inc. (NI) of Austin, Texas to measure the IE velocity of the Aluminum Cylinder calibration specimen. This procedure is accurate within 0.3% in identifying the constant IE velocity of the Aluminum.

Sensor: IE Scanner Roller

Data Collection: Freedom Data PC w/ National Instruments Card

Solenoid Impactor @ centerline of cylinder end

DAC card: NI PCI-MIO-16E-1, S/N 10096AE

National Instruments calibration - 3/29/ 2002

The digital sampling of the 40 IE tests was done at a time per point of 10 microseconds (1/10 μs = 100,000 Hz time domain sampling rate) for 4000 data points and recorded in file Call on November 1, 2002. The 40 time domain results (40 milliseconds of data per test) were analyzed using a Fast Fourier Transform (FFT) algorithm from the Measurement Studios software of NI which produced 40 linear frequency spectrum of the displacement transducer response of the IE Scanner Roller that all had a dominant longitudinal echo thickness peak frequency at f = 8,300 Hz. The Nyquist Frequency of the testing was f_N = 50,000 Hz (100,000 Hz/2) and the change in frequency between the spectral lines was 25 Hz (Δf/spectral line. = 50,000 Hz/2000 lines). The difference by a factor of 2 between time domain sampling and frequency domain analysis is due to the digital sampling theorem that there be just more than 2 digital data points per the highest frequency that is generated and can be correctly sampled without aliasing contamination of the data. The Impact Echo sound velocity of the aluminum cylinder V_{IE} is calculated by multiplying the cylinder length by twice the resonant thickness frequency, i.e. V_{IE} = 2 x 1ft x 8300 Hz = 16,600 ft/sec = 16,600 fps. The accuracy of this velocity measurement is within the Δf of 25 Hz, i.e. 8300 Hz ± 25 Hz in the above equation for V_{IE}. This results in the value of V_{IE} lying between a low of 16,550 to a high of 16,550 fps or an accuracy of better than 0.30 %.

4.4 Impact Echo Results

Impact Echo tests were conducted at 944 locations throughout the slab. Each test point was assigned a grid name, based on either a 4'x4' or 2'x2' grid. The layout of the grid can be found in Fig.1A in Appendix A. The results at each IE test are presented in Table IA in Appendix A. Table IA includes the test zone (grid location), measured and expected thickness, the percent error, and the pass/fail rating. All test points received a pass rating. The mean of the totaled measured values equaled 60.17 inches with a standard deviation of 2 inches. The maximum and minimum values were 66 and 54 inches, respectively.

5.0 CORE TEST PROGRAM

Core samples were taken at 9 locations on the southeast slab of the LAW facility as designated by Olson Engineering. Cores were taken in areas of full 5-ft thick finished areas as well as areas in the chipped out cold joint portion of the slab. Pro Cut, Inc. of Richland, Washington performed the coring for Bechtel as shown in Fig. 6, using a nominal 4 inch diameter core barrel. Rebar was located with a cover meter by Bechtel National, Inc. in full thickness locations and by visual inspection in chipped out areas.

Figure 6 - Pro Cut, Inc. drilling at core location 8

The American Concrete Institute (ACI) 318 Building Code Section 5.6.5 provides for investigation of low-strength test results using 3 cores and the concrete is considered structurally adequate if the average of three cores is equal to at least 85% of f'_c and no single core is less than at least 75% of f'_c. ACI 318 Section 5.6.2.1 requires test cylinders to be obtained at least once a day for at least every 150 yd^3 or 5000 ft^2 of surface area for slabs or walls. Considering that about 1200 yd^3 of concrete was placed, 8 core locations and 24 core specimens would need to be tested for compressive strength. Also, for the nominally 10,000 ft^2 slab a total of 6 core strength tests would be required as a minimum. A total of 9 core locations were selected across the slab to cover areas of full 5 ft thickness to the thinnest cold joint section which resulted in 29 core specimens for compressive strength tests, which exceeds the most stringent ACI criteria. The samples were located to check for internal thermal cracking in full-thickness and cold joint areas and in an attempt to sample near-surface questionable quality concrete that still remained in some cold joint areas after initial chip-out and removal operations. Figure 7 below shows the 9 core locations.

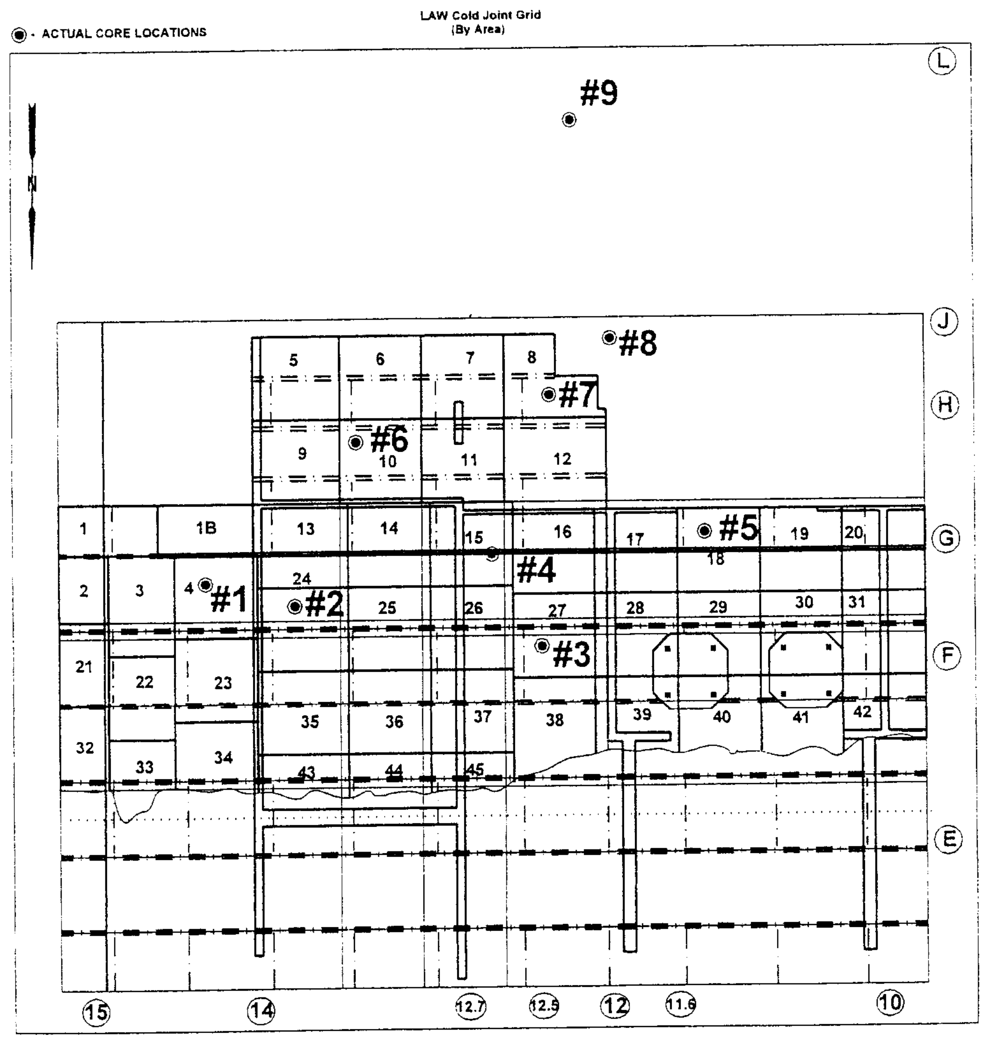


Figure 7 - Actual Core Locations

5.1 Laboratory Test Program and Results

GN Northern, Inc., onsite materials subcontractor for Bechtel National, performed laboratory tests on selected core samples. The laboratory tests performed were compressive strength and unit weight. Olson Engineering also performed Ultrasonic Pulse Velocity testing (ASTM C 597) on the core samples available in the field (see Fig 8) . Table I summarizes the laboratory test program and presents the results of each test. The GN Northern report is presented in Appendix A and contains the detailed laboratory results.

The average diameter of the core samples was 3.66 inches The average ultrasonic pulse velocity (UPV) measured in the field was 15,000 fps, with a maximum velocity of 15,800 fps and a minimum velocity of 13,800 fps. These values are indicative of good quality concrete. The compressive strength tests were conducted per ASTM C42-99, C39-01 (see Figs. 9 and 10) and yielded an average value of 5,249 psi, with minimum and maximum values of 4,030 psi and 6,050 psi respectively. All values exceeded the minimum compressive strength requirement of 4,000 psi and met the ACI 318-5.6.5 criteria. The average unit weight calculated from the core samples is 152.1 pcf, with minimum and maximum values of 149.5 pcf and 155.3 pcf respectively which are typical of normally consolidated concrete. Table I summarizes the results of the laboratory test program. Photographs of each full length core recovered can be found in Appendix B. Table II summarizes the core log, which states the observed conditions of the cores before testing.

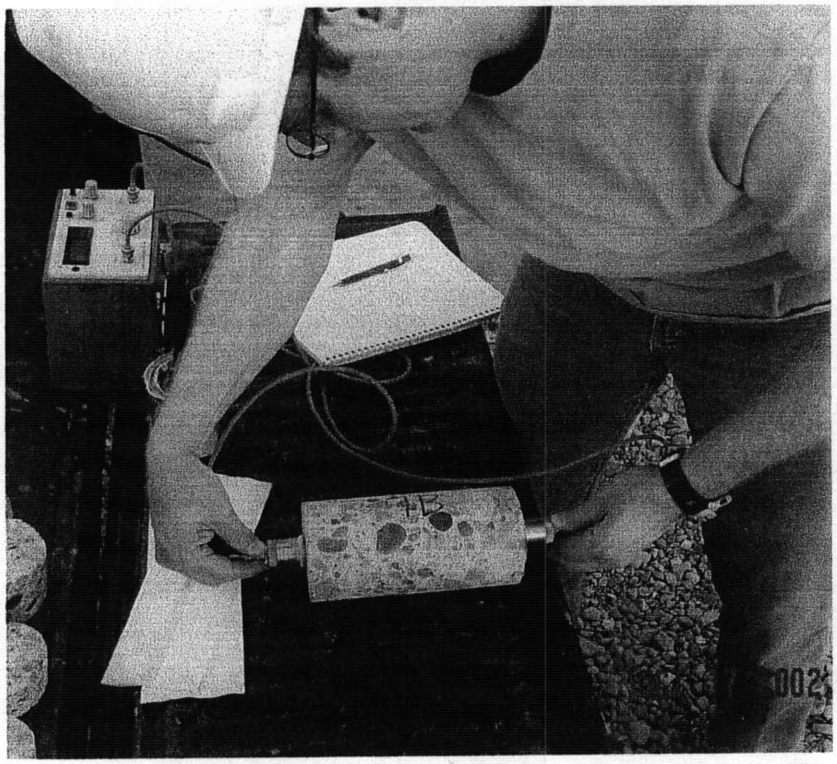


Figure 8 - Ultrasonic Pulse Velocity test performed on Core 7B


Figure 9 - Core Sample in Universal Testing Machine

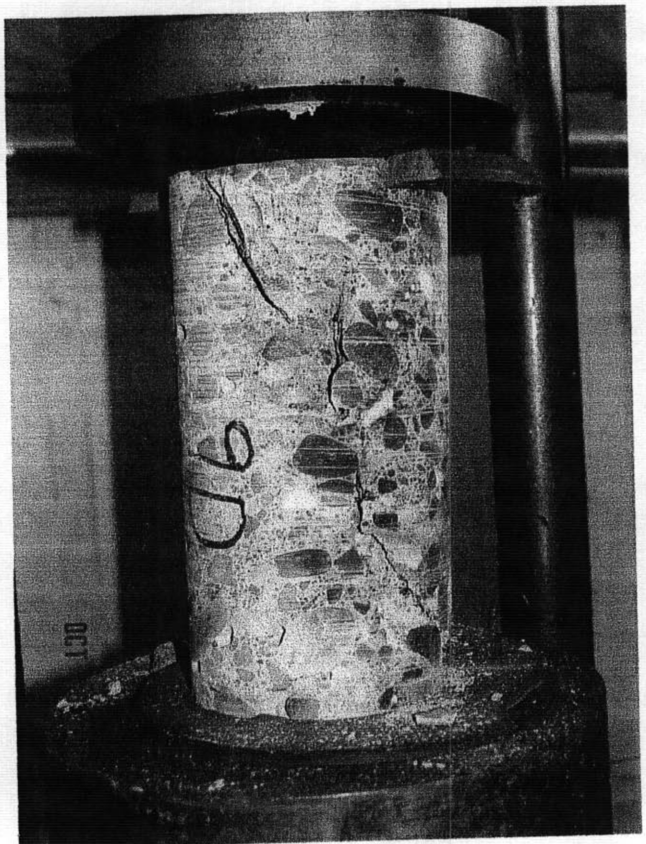


Figure 10 - Core Sample 9D immediately after failure

Table I

Laboratory Core Testing Results

Core I.D.	Unit Wt. (pcf)	Compressive Strength (psi)	Pulse Velocity (fps)
1A	152.0	5710	N/A
1B	150.7	6130	14,500
1C	150.5	5550	14,500
1D	153.4	5300	13,900
2A	151.7	4450	N/A
2B	152.5	5410	14,700
2C	152.0	4780	15,100
2D	152.7	4260	15,300
3A	151.3	5740	13,800
4A	149.5	5410	14,100
4B	153.8	5180	15,300
5A	151.7	5710	N/A
5B	149.5	5780	N/A
5C	N/A	N/A	N/A
5D	150.1	4030	N/A
6A	152.2	5180	N/A
6B	151.7	5810	15,400
6C	155.3	5990	15,200
6D	152.5	5790	15,100
7A	N/A	N/A	15,100
7B	151.8	5260	15,000
7C	153.0	4820	15,800
8A	153.8	6050	N/A
8B	152.1	5730	14,800
8C	151.4	5040	14,900
8D	152.8	4510	15,800
8E	151.3	4810	14,300
9A	154.7	4130	15,200
9B	152.1	4940	14,800
9C	152.8	4710	15,600
9D	152.3	5820	15,800
Average	**152.1**	**5242**	**15,000**
Std. Dev.	**1.4**	**602**	**600**
Max.	**155.3**	**6130**	**15,800**
Min.	**149.5**	**4030**	**13,800**

5.2 Core Observations and Logs

The core locations did not correspond exactly to the initial NDT test locations. This was due to access constraints as a result of the dense rebar spacing. The core locations did, however, adequately cover the areas of concern. Direct observation of the core samples did not show appreciable depths of questionable quality concrete. The ease at which both manual and mechanical chipping removed the upper layers of concrete, however, suggest weak concrete does exist in the shallow layers of the slab. Some cores did contain minor, isolated voids, as noted in Table II, but not to an extent greater than expected in normal good quality concrete. The results of the density tests support this assertion, with an average density of 152.1 pcf. Photographs of cores and typical voids can be found in Appendix C.

Table II

Core Log

Core I.D.	Total Length	Minor Voids (from top)	Breaks (from top)	Aggregate Depth Change (from top)
Core 1	37"	None	None	None
Core 2	37"	10", 21"	None	None
Core 3	14"	21-25", 31", 36"	None	None
Core 4	17.5"	3-5"	None	None
Core 5	36"	7", 13", 24"	20"	None
Core 6	38"	10", 21"	None	None
Core 7	41"	3-5"	22.5", 28.5"	None
Core 8	46.5"	21-25", 31", 36"	None	None
Core 9	45"	19", 38"	3.5"	12"

6.0 CLOSURE

This investigation was performed in accordance with generally accepted testing procedures. If additional information is developed that is pertinent to the findings of this investigation or we can provide any additional information, please contact our office.

Respectfully Submitted,

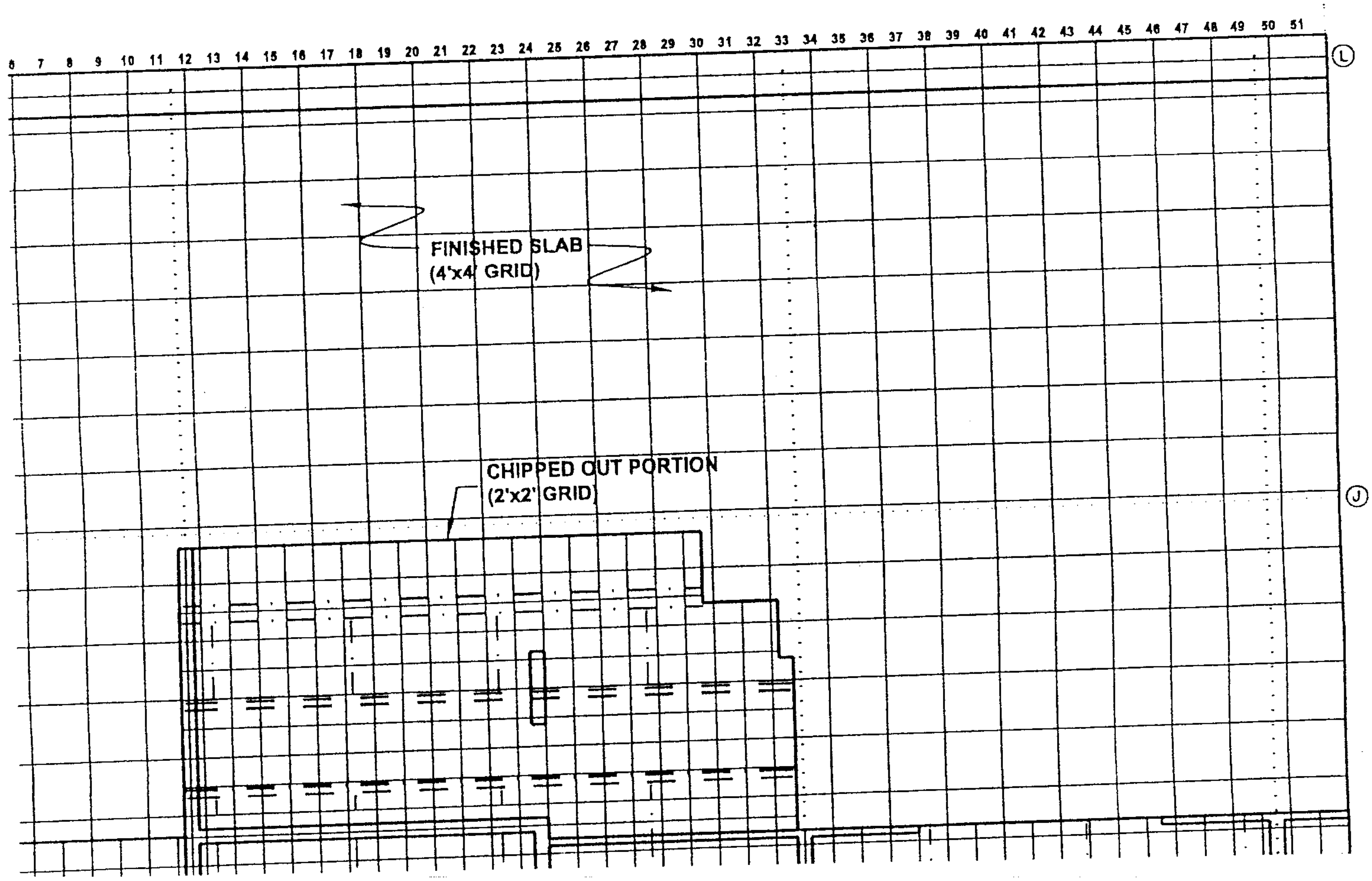
OLSON ENGINEERING, INC.

Raymond Q. Raparelli, P.E.
Project Engineer

Larry D. Olson, P.E.
President and Principal Engineer

Appendix A

IE Test Results



6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51
L
FINISHED SLAB
(4'x4' GRID)
CHIPPED OUT PORTION
(2'x2' GRID)
J

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
A02	0.0	62.3	62.3	60	3.83%	Pass
A04	0.0	62.3	62.3	60	3.83%	Pass
A06	0.0	58.2	58.2	60	-3.00%	Pass
A08	0.0	58.2	58.2	60	-3.00%	Pass
A10	0.0	59.5	59.5	60	-0.83%	Pass
A12	0.0	59.5	59.5	60	-0.83%	Pass
A14	0.0	59.5	59.5	60	-0.83%	Pass
A16	0.0	59.5	59.5	60	-0.83%	Pass
A18	0.0	59.5	59.5	60	-0.83%	Pass
A20	0.0	59.5	59.5	60	-0.83%	Pass
A22	0.0	59.5	59.5	60	-0.83%	Pass
A24	0.0	58.2	58.2	60	-3.00%	Pass
A26	0.0	58.2	58.2	60	-3.00%	Pass
A28	0.0	58.2	58.2	60	-3.00%	Pass
A30	0.0	58.2	58.2	60	-3.00%	Pass
A32	0.0	58.2	58.2	60	-3.00%	Pass
A34	0.0	58.2	58.2	60	-3.00%	Pass
A36	0.0	58.2	58.2	60	-3.00%	Pass
A38	0.0	58.2	58.2	60	-3.00%	Pass
A40	0.0	58.0	58	60	-3.33%	Pass
A42	0.0	56.9	56.9	60	-5.17%	Pass
A44	0.0	58.2	58.2	60	-3.00%	Pass
A46	0.0	56.9	56.9	60	-5.17%	Pass
A48	0.0	58.2	58.2	60	-3.00%	Pass
A50	0.0	59.5	59.5	60	-0.83%	Pass
B02	0.0	55.7	55.7	60	-7.17%	Pass
B04	0.0	59.5	59.5	60	-0.83%	Pass
B06	0.0	58.2	58.2	60	-3.00%	Pass
B08	0.0	58.2	58.2	60	-3.00%	Pass
B10	0.0	58.2	58.2	60	-3.00%	Pass
B12	0.0	59.5	59.5	60	-0.83%	Pass
B14	0.0	59.5	59.5	60	-0.83%	Pass
B16	0.0	59.5	59.5	60	-0.83%	Pass
B18	0.0	59.5	59.5	60	-0.83%	Pass
B20	0.0	59.5	59.5	60	-0.83%	Pass
B22	0.0	59.5	59.5	60	-0.83%	Pass
B24	0.0	59.5	59.5	60	-0.83%	Pass
B26	0.0	59.5	59.5	60	-0.83%	Pass
B28	0.0	59.5	59.5	60	-0.83%	Pass
B30	0.0	59.5	59.5	60	-0.83%	Pass
B32	0.0	59.5	59.5	60	-0.83%	Pass
B34	0.0	58.2	58.2	60	-3.00%	Pass
B36	0.0	58.2	58.2	60	-3.00%	Pass
B38	0.0	59.5	59.5	60	-0.83%	Pass
B40	0.0	59.5	59.5	60	-0.83%	Pass
B42	0.0	59.5	59.5	60	-0.83%	Pass
B44	0.0	58.2	58.2	60	-3.00%	Pass
B46	0.0	58.2	58.2	60	-3.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
B48	0.0	59.5	59.5	60	-0.83%	Pass
B50	0.0	63.9	63.9	60	6.50%	Pass
C02	0.0	63.9	63.9	60	6.50%	Pass
C04	0.0	58.2	58.2	60	-3.00%	Pass
C06	0.0	58.2	58.2	60	-3.00%	Pass
C08	0.0	58.2	58.2	60	-3.00%	Pass
C10	0.0	58.2	58.2	60	-3.00%	Pass
C12	0.0	59.5	59.5	60	-0.83%	Pass
C14	0.0	59.5	59.5	60	-0.83%	Pass
C16	0.0	58.2	58.2	60	-3.00%	Pass
C18	0.0	58.2	58.2	60	-3.00%	Pass
C20	0.0	59.5	59.5	60	-0.83%	Pass
C22	0.0	59.5	59.5	60	-0.83%	Pass
C24	0.0	59.5	59.5	60	-0.83%	Pass
C26	0.0	59.5	59.5	60	-0.83%	Pass
C28	0.0	59.5	59.5	60	-0.83%	Pass
C30	0.0	63.9	63.9	60	6.50%	Pass
C32	0.0	59.5	59.5	60	-0.83%	Pass
C34	0.0	59.5	59.5	60	-0.83%	Pass
C36	0.0	58.2	58.2	60	-3.00%	Pass
C38	0.0	59.5	59.5	60	-0.83%	Pass
C40	0.0	59.5	59.5	60	-0.83%	Pass
C42	0.0	59.5	59.5	60	-0.83%	Pass
C44	0.0	59.5	59.5	60	-0.83%	Pass
C46	0.0	59.5	59.5	60	-0.83%	Pass
C48	0.0	59.5	59.5	60	-0.83%	Pass
C50	0.0	59.5	59.5	60	-0.83%	Pass
D02	0.0	60.9	60.9	60	1.50%	Pass
D04	0.0	58.2	58.2	60	-3.00%	Pass
D06	0.0	58.2	58.2	60	-3.00%	Pass
D08	0.0	58.2	58.2	60	-3.00%	Pass
D10	0.0	58.2	58.2	60	-3.00%	Pass
D12	0.0	58.2	58.2	60	-3.00%	Pass
D14	0.0	58.2	58.2	60	-3.00%	Pass
D16	0.0	58.2	58.2	60	-3.00%	Pass
D18	0.0	58.2	58.2	60	-3.00%	Pass
D20	0.0	58.2	58.2	60	-3.00%	Pass
D22	0.0	58.2	58.2	60	-3.00%	Pass
D24	0.0	58.2	58.2	60	-3.00%	Pass
D26	0.0	59.5	59.5	60	-0.83%	Pass
D28	0.0	59.5	59.5	60	-0.83%	Pass
D30	0.0	60.9	60.9	60	1.50%	Pass
D32	0.0	59.5	59.5	60	-0.83%	Pass
D34	0.0	58.2	58.2	60	-3.00%	Pass
D36	0.0	58.2	58.2	60	-3.00%	Pass
D38	0.0	59.5	59.5	60	-0.83%	Pass
D40	0.0	59.5	59.5	60	-0.83%	Pass
D42	0.0	59.5	59.5	60	-0.83%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
D44	0.0	58.2	58.2	60	-3.00%	Pass
D46	0.0	58.2	58.2	60	-3.00%	Pass
D48	0.0	59.5	59.5	60	-0.83%	Pass
D50	0.0	59.5	59.5	60	-0.83%	Pass
E02	0.0	58.2	58.2	60	-3.00%	Pass
E04	0.0	58.2	58.2	60	-3.00%	Pass
E06	0.0	58.2	58.2	60	-3.00%	Pass
E08	0.0	58.2	58.2	60	-3.00%	Pass
E10	0.0	58.2	58.2	60	-3.00%	Pass
E12	0.0	58.2	58.2	60	-3.00%	Pass
E14	0.0	58.2	58.2	60	-3.00%	Pass
E16	0.0	59.5	59.5	60	-0.83%	Pass
E18	0.0	59.5	59.5	60	-0.83%	Pass
E20	0.0	58.2	58.2	60	-3.00%	Pass
E22	0.0	62.3	62.3	60	3.83%	Pass
E24	0.0	59.5	59.5	60	-0.83%	Pass
E26	0.0	59.5	59.5	60	-0.83%	Pass
E28	0.0	59.5	59.5	60	-0.83%	Pass
E30	0.0	60.9	60.9	60	1.50%	Pass
E32	0.0	59.5	59.5	60	-0.83%	Pass
E34	0.0	59.5	59.5	60	-0.83%	Pass
E36	0.0	59.5	59.5	60	-0.83%	Pass
E38	0.0	59.5	59.5	60	-0.83%	Pass
E40	0.0	59.5	59.5	60	-0.83%	Pass
E42	0.0	59.5	59.5	60	-0.83%	Pass
E44	0.0	59.5	59.5	60	-0.83%	Pass
E46	0.0	59.5	59.5	60	-0.83%	Pass
E48	0.0	59.5	59.5	60	-0.83%	Pass
E50	0.0	58.2	58.2	60	-3.00%	Pass
F02	0.0	59.5	59.5	60	-0.83%	Pass
F04	0.0	58.2	58.2	60	-3.00%	Pass
F06	0.0	58.2	58.2	60	-3.00%	Pass
F08	0.0	58.2	58.2	60	-3.00%	Pass
F10	0.0	58.2	58.2	60	-3.00%	Pass
F12	0.0	58.2	58.2	60	-3.00%	Pass
F14	0.0	58.2	58.2	60	-3.00%	Pass
F16	0.0	59.5	59.5	60	-0.83%	Pass
F18	0.0	58.2	58.2	60	-3.00%	Pass
F20	0.0	58.2	58.2	60	-3.00%	Pass
F22	0.0	59.5	59.5	60	-0.83%	Pass
F24	0.0	59.5	59.5	60	-0.83%	Pass
F26	0.0	59.5	59.5	60	-0.83%	Pass
F28	0.0	59.5	59.5	60	-0.83%	Pass
F30	0.0	59.5	59.5	60	-0.83%	Pass
F32	0.0	59.5	59.5	60	-0.83%	Pass
F34	0.0	59.5	59.5	60	-0.83%	Pass
F36	0.0	59.5	59.5	60	-0.83%	Pass
F38	0.0	59.5	59.5	60	-0.83%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
F40	0.0	59.5	59.5	60	-0.83%	Pass
F42	0.0	59.5	59.5	60	-0.83%	Pass
F44	0.0	59.5	59.5	60	-0.83%	Pass
F46	0.0	59.5	59.5	60	-0.83%	Pass
F48	0.0	59.5	59.5	60	-0.83%	Pass
F50	0.0	59.5	59.5	60	-0.83%	Pass
G02	0.0	59.5	59.5	60	-0.83%	Pass
G04	0.0	59.5	59.5	60	-0.83%	Pass
G06	0.0	58.2	58.2	60	-3.00%	Pass
G08	0.0	58.2	58.2	60	-3.00%	Pass
G10	0.0	58.2	58.2	60	-3.00%	Pass
G12	0.0	58.2	58.2	60	-3.00%	Pass
G14	0.0	59.5	59.5	60	-0.83%	Pass
G16	0.0	59.5	59.5	60	-0.83%	Pass
G18	0.0	59.5	59.5	60	-0.83%	Pass
G20	0.0	59.5	59.5	60	-0.83%	Pass
G22	0.0	58.2	58.2	60	-3.00%	Pass
G24	0.0	59.5	59.5	60	-0.83%	Pass
G26	0.0	59.5	59.5	60	-0.83%	Pass
G28	0.0	59.5	59.5	60	-0.83%	Pass
G30	0.0	59.5	59.5	60	-0.83%	Pass
G32	0.0	59.5	59.5	60	-0.83%	Pass
G34	0.0	58.2	58.2	60	-3.00%	Pass
G36	0.0	58.2	58.2	60	-3.00%	Pass
G38	0.0	58.2	58.2	60	-3.00%	Pass
G40	0.0	58.2	58.2	60	-3.00%	Pass
G42	0.0	58.2	58.2	60	-3.00%	Pass
G44	0.0	58.2	58.2	60	-3.00%	Pass
G46	0.0	58.2	58.2	60	-3.00%	Pass
G48	0.0	58.2	58.2	60	-3.00%	Pass
G50	0.0	58.2	58.2	60	-3.00%	Pass
H02	0.0	60.9	60.9	60	1.50%	Pass
H04	0.0	58.2	58.2	60	-3.00%	Pass
H06	0.0	59.5	59.5	60	-0.83%	Pass
H08	0.0	58.2	58.2	60	-3.00%	Pass
H10	0.0	58.2	58.2	60	-3.00%	Pass
H12	0.0	58.2	58.2	60	-3.00%	Pass
H14	0.0	58.2	58.2	60	-3.00%	Pass
H16	0.0	58.2	58.2	60	-3.00%	Pass
H18	0.0	58.2	58.2	60	-3.00%	Pass
H20	0.0	59.5	59.5	60	-0.83%	Pass
H22	0.0	59.5	59.5	60	-0.83%	Pass
H24	0.0	58.2	58.2	60	-3.00%	Pass
H26	0.0	58.2	58.2	60	-3.00%	Pass
H28	0.0	58.2	58.2	60	-3.00%	Pass
H30	0.0	59.5	59.5	60	-0.83%	Pass
H32	0.0	59.5	59.5	60	-0.83%	Pass
H34	0.0	58.2	58.2	60	-3.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
H36	0.0	58.2	58.2	60	-3.00%	Pass
H38	0.0	58.2	58.2	60	-3.00%	Pass
H40	0.0	59.5	59.5	60	-0.83%	Pass
H42	0.0	59.5	59.5	60	-0.83%	Pass
H44	0.0	58.2	58.2	60	-3.00%	Pass
H46	0.0	58.2	58.2	60	-3.00%	Pass
H48	0.0	58.2	58.2	60	-3.00%	Pass
H50	0.0	58.2	58.2	60	-3.00%	Pass
I30	0.0	59.5	59.5	60	-0.83%	Pass
I32	0.0	59.5	59.5	60	-0.83%	Pass
I34	0.0	59.5	59.5	60	-0.83%	Pass
I36	0.0	59.5	59.5	60	-0.83%	Pass
I38	0.0	59.5	59.5	60	-0.83%	Pass
I40	0.0	59.5	59.5	60	-0.83%	Pass
I42	0.0	59.5	59.5	60	-0.83%	Pass
I44	0.0	59.5	59.5	60	-0.83%	Pass
I46	0.0	59.5	59.5	60	-0.83%	Pass
I48	0.0	59.5	59.5	60	-0.83%	Pass
I50	0.0	59.5	59.5	60	-0.83%	Pass
J02	0.0	63.9	63.9	60	6.50%	Pass
J04	0.0	58.2	58.2	60	-3.00%	Pass
J06	0.0	58.2	58.2	60	-3.00%	Pass
J08	0.0	59.5	59.5	60	-0.83%	Pass
J10	0.0	59.5	59.5	60	-0.83%	Pass
J12	0.0	59.5	59.5	60	-0.83%	Pass
J13	10.0	50.4	60.4	60	0.67%	Pass
J14	10.0	50.4	60.4	60	0.67%	Pass
J15	11.0	48.5	59.5	60	-0.83%	Pass
J16	10.5	50.4	60.9	60	1.50%	Pass
J17	11.0	50.4	61.4	60	2.33%	Pass
J18	11.5	50.4	61.9	60	3.17%	Pass
J19	11.5	50.4	61.9	60	3.17%	Pass
J20	11.5	48.5	60	60	0.00%	Pass
J21	11.8	53.4	65.15	60	8.58%	Pass
J22	12.0	49.4	61.4	60	2.33%	Pass
J23	12.5	50.4	62.9	60	4.83%	Pass
J24	11.0	49.4	60.4	60	0.67%	Pass
J25	13.5	46.8	60.3	60	0.50%	Pass
J26	12.0	42.9	54.9	60	-8.50%	Pass
J27	22.0	39.1	61.1	60	1.83%	Pass
J28	22.0	39.7	61.7	60	2.83%	Pass
J34	0.0	58.2	58.2	60	-3.00%	Pass
J36	0.0	59.5	59.5	60	-0.83%	Pass
J38	0.0	58.2	58.2	60	-3.00%	Pass
J40	0.0	58.2	58.2	60	-3.00%	Pass
J42	0.0	59.5	59.5	60	-0.83%	Pass
J44	0.0	59.5	59.5	60	-0.83%	Pass
J46	0.0	59.5	59.5	60	-0.83%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
J48	0.0	59.5	59.5	60	-0.83%	Pass
J50	0.0	59.5	59.5	60	-0.83%	Pass
K12	10.0	51.3	61.3	60	2.17%	Pass
K13	11.5	51.3	62.8	60	4.67%	Pass
K14	10.5	48.5	59	60	-1.67%	Pass
K15	11.5	48.5	60	60	0.00%	Pass
K16	11.5	51.3	62.8	60	4.67%	Pass
K17	11.5	50.4	61.9	60	3.17%	Pass
K18	12.5	51.3	63.8	60	6.33%	Pass
K19	12.0	47.6	59.6	60	-0.67%	Pass
K20	12.5	49.4	61.9	60	3.17%	Pass
K21	13.0	47.6	60.6	60	1.00%	Pass
K22	12.0	47.6	59.6	60	-0.67%	Pass
K23	12.0	49.4	61.4	60	2.33%	Pass
K24	13.0	45.9	58.9	60	-1.83%	Pass
K25	13.0	45.1	58.1	60	-3.17%	Pass
K26	20.5	40.9	61.4	60	2.33%	Pass
K27	21.0	40.3	61.3	60	2.17%	Pass
K28	21.0	39.1	60.1	60	0.17%	Pass
K29	19.5	34.5	54	60	-10.00%	Pass
K36	0.0	59.5	59.5	60	-0.83%	Pass
K38	0.0	58.2	58.2	60	-3.00%	Pass
K40	0.0	58.2	58.2	60	-3.00%	Pass
K42	0.0	59.5	59.5	60	-0.83%	Pass
K44	0.0	59.5	59.5	60	-0.83%	Pass
K46	0.0	59.5	59.5	60	-0.83%	Pass
K48	0.0	58.2	58.2	60	-3.00%	Pass
K50	0.0	58.2	58.2	60	-3.00%	Pass
L02	0.0	58.2	58.2	60	-3.00%	Pass
L04	0.0	58.2	58.2	60	-3.00%	Pass
L06	0.0	59.5	59.5	60	-0.83%	Pass
L08	0.0	59.5	59.5	60	-0.83%	Pass
L10	0.0	60.9	60.9	60	1.50%	Pass
L12	0.0	62.3	62.3	60	3.83%	Pass
L12	11.0	48.5	59.5	60	-0.83%	Pass
L13	11.5	48.5	60	60	0.00%	Pass
L14	10.5	48.5	59	60	-1.67%	Pass
L15	11.5	48.5	60	60	0.00%	Pass
L16	11.5	48.5	60	60	0.00%	Pass
L17	11.5	47.6	59.1	60	-1.50%	Pass
L18	11.5	46.8	58.3	60	-2.83%	Pass
L19	12.0	46.8	58.8	60	-2.00%	Pass
L20	12.0	46.8	58.8	60	-2.00%	Pass
L21	11.5	46.8	58.3	60	-2.83%	Pass
L22	12.5	47.6	60.1	60	0.17%	Pass
L23	12.5	46.8	59.3	60	-1.17%	Pass
L24	13.0	45.9	58.9	60	-1.83%	Pass
L25	16.5	45.9	62.4	60	4.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
L26	21.0	42.2	63.2	60	5.33%	Pass
L27	21.0	42.9	63.9	60	6.50%	Pass
L28	19.5	44.4	63.9	60	6.50%	Pass
L29	19.5	41.6	61.1	60	1.83%	Pass
L30	19.5	42.2	61.7	60	2.83%	Pass
L31	19.5	43.6	63.1	60	5.17%	Pass
L32	18.5	39.7	58.2	60	-3.00%	Pass
L34	0.0	58.2	58.2	60	-3.00%	Pass
L36	0.0	59.5	59.5	60	-0.83%	Pass
L38	0.0	59.5	59.5	60	-0.83%	Pass
L40	0.0	59.5	59.5	60	-0.83%	Pass
L42	0.0	59.5	59.5	60	-0.83%	Pass
L44	0.0	59.5	59.5	60	-0.83%	Pass
L46	0.0	59.5	59.5	60	-0.83%	Pass
L48	0.0	59.5	59.5	60	-0.83%	Pass
L50	0.0	58.2	58.2	60	-3.00%	Pass
M12	10.5	51.3	61.8	60	3.00%	Pass
M13	11.3	49.4	60.65	60	1.08%	Pass
M14	10.0	50.4	60.4	60	0.67%	Pass
M15	11.5	47.6	59.1	60	-1.50%	Pass
M16	12.3	47.6	59.85	60	-0.25%	Pass
M17	12.0	47.6	59.6	60	-0.67%	Pass
M18	12.0	47.6	59.6	60	-0.67%	Pass
M19	12.0	46.8	58.8	60	-2.00%	Pass
M20	11.8	45.9	57.65	60	-3.92%	Pass
M21	11.8	46.8	58.55	60	-2.42%	Pass
M22	12.0	47.6	59.6	60	-0.67%	Pass
M23	12.5	46.8	59.3	60	-1.17%	Pass
M24	13.0	46.8	59.8	60	-0.33%	Pass
M25	12.5	47.6	60.1	60	0.17%	Pass
M26	12.0	52.4	64.4	60	7.33%	Pass
M27	12.0	49.4	61.4	60	2.33%	Pass
M28	10.0	52.4	62.4	60	4.00%	Pass
M29	10.0	51.3	61.3	60	2.17%	Pass
M30	10.0	49.4	59.4	60	-1.00%	Pass
M31	10.0	49.4	59.4	60	-1.00%	Pass
M32	10.0	52.4	62.4	60	4.00%	Pass
M34	0.0	59.5	59.5	60	-0.83%	Pass
M36	0.0	59.5	59.5	60	-0.83%	Pass
M38	0.0	59.5	59.5	60	-0.83%	Pass
M40	0.0	59.5	59.5	60	-0.83%	Pass
M42	0.0	59.5	59.5	60	-0.83%	Pass
M44	0.0	59.5	59.5	60	-0.83%	Pass
M46	0.0	59.5	59.5	60	-0.83%	Pass
M48	0.0	62.3	62.3	60	3.83%	Pass
M50	0.0	63.9	63.9	60	6.50%	Pass
N02	0.0	63.9	63.9	60	6.50%	Pass
N04	0.0	58.2	58.2	60	-3.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
N06	0.0	59.5	59.5	60	-0.83%	Pass
N08	0.0	59.5	59.5	60	-0.83%	Pass
N10	0.0	60.9	60.9	60	1.50%	Pass
N12	0.0	60.9	60.9	60	1.50%	Pass
N12	11.0	47.6	58.6	60	-2.33%	Pass
N13	10.5	49.4	59.9	60	-0.17%	Pass
N14	10.5	48.5	59	60	-1.67%	Pass
N15	12.0	48.5	60.5	60	0.83%	Pass
N16	13.0	46.8	59.8	60	-0.33%	Pass
N17	12.5	46.8	59.3	60	-1.17%	Pass
N18	12.8	46.8	59.55	60	-0.75%	Pass
N19	13.0	45.9	58.9	60	-1.83%	Pass
N20	12.8	45.9	58.65	60	-2.25%	Pass
N21	13.0	46.8	59.8	60	-0.33%	Pass
N22	12.8	45.9	58.65	60	-2.25%	Pass
N23	13.0	46.8	59.8	60	-0.33%	Pass
N24	14.0	47.6	61.6	60	2.67%	Pass
N25	13.0	47.6	60.6	60	1.00%	Pass
N26	13.0	47.6	60.6	60	1.00%	Pass
N27	13.3	48.5	61.75	60	2.92%	Pass
N28	12.5	48.5	61	60	1.67%	Pass
N29	12.8	48.5	61.25	60	2.08%	Pass
N30	11.5	48.5	60	60	0.00%	Pass
N31	11.0	49.4	60.4	60	0.67%	Pass
N32	11.0	49.4	60.4	60	0.67%	Pass
N33	0.0	58.2	58.2	60	-3.00%	Pass
O12	10.5	51.3	61.8	60	3.00%	Pass
O13	11.0	52.4	63.4	60	5.67%	Pass
O14	10.0	52.4	62.4	60	4.00%	Pass
O15	10.5	48.5	59	60	-1.67%	Pass
O16	12.0	47.6	59.6	60	-0.67%	Pass
O17	12.0	47.6	59.6	60	-0.67%	Pass
O18	12.5	47.6	60.1	60	0.17%	Pass
O19	12.0	48.5	60.5	60	0.83%	Pass
O20	12.0	48.5	60.5	60	0.83%	Pass
O21	13.0	47.6	60.6	60	1.00%	Pass
O22	12.5	47.6	60.1	60	0.17%	Pass
O23	12.5	46.8	59.3	60	-1.17%	Pass
O24	12.0	46.8	58.8	60	-2.00%	Pass
O25	12.0	47.6	59.6	60	-0.67%	Pass
O26	12.0	48.5	60.5	60	0.83%	Pass
O27	12.5	48.5	61	60	1.67%	Pass
O28	12.0	48.5	60.5	60	0.83%	Pass
O29	12.0	48.5	60.5	60	0.83%	Pass
O30	12.5	48.5	61	60	1.67%	Pass
O31	11.5	49.4	60.9	60	1.50%	Pass
O32	11.5	48.5	60	60	0.00%	Pass
P02	0.0	58.2	58.2	60	-3.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
P04	0.0	58.2	58.2	60	-3.00%	Pass
P06	0.0	58.2	58.2	60	-3.00%	Pass
P08	0.0	59.5	59.5	60	-0.83%	Pass
P10	0.0	60.9	60.9	60	1.50%	Pass
P12	0.0	60.9	60.9	60	1.50%	Pass
P13	11.0	52.4	63.4	60	5.67%	Pass
P14	10.5	51.3	61.8	60	3.00%	Pass
P15	NA	NA	NA	NA	NA	NA
P16	10.5	47.6	58.1	60	-3.17%	Pass
P17	11.5	51.3	62.8	60	4.67%	Pass
P18	11.5	48.5	60	60	0.00%	Pass
P19	12.0	49.4	61.4	60	2.33%	Pass
P20	12.5	47.6	60.1	60	0.17%	Pass
P21	12.0	48.5	60.5	60	0.83%	Pass
P22	12.5	46.8	59.3	60	-1.17%	Pass
P23	13.0	48.5	61.5	60	2.50%	Pass
P24	13.5	47.6	61.1	60	1.83%	Pass
P25	12.5	48.5	61	60	1.67%	Pass
P26	12.5	52.4	64.9	60	8.17%	Pass
P27	11.5	52.4	63.9	60	6.50%	Pass
P28	12.0	50.4	62.4	60	4.00%	Pass
P29	12.0	48.5	60.5	60	0.83%	Pass
P30	12.0	53.4	65.4	60	9.00%	Pass
P31	10.0	47.6	57.6	60	-4.00%	Pass
P32	11.5	48.5	60	60	0.00%	Pass
P33	12.0	48.5	60.5	60	0.83%	Pass
Q12	10.0	49.4	59.4	60	-1.00%	Pass
Q13	12.0	49.4	61.4	60	2.33%	Pass
Q14	12.0	48.5	60.5	60	0.83%	Pass
Q15	NA	NA	NA	NA	NA	NA
Q16	10.5	49.4	59.9	60	-0.17%	Pass
Q17	12.0	48.5	60.5	60	0.83%	Pass
Q18	12.0	48.5	60.5	60	0.83%	Pass
Q19	12.0	46.8	58.8	60	-2.00%	Pass
Q20	12.5	47.6	60.1	60	0.17%	Pass
Q21	12.0	47.6	59.6	60	-0.67%	Pass
Q22	13.0	47.6	60.6	60	1.00%	Pass
Q23	12.5	47.6	60.1	60	0.17%	Pass
Q24	12.5	47.6	60.1	60	0.17%	Pass
Q25	13.0	48.5	61.5	60	2.50%	Pass
Q26	12.0	53.4	65.4	60	9.00%	Pass
Q27	12.5	49.5	62	60	3.33%	Pass
Q28	12.0	48.5	60.5	60	0.83%	Pass
Q29	12.5	48.5	61	60	1.67%	Pass
Q30	12.5	49.4	61.9	60	3.17%	Pass
Q31	12.0	48.5	60.5	60	0.83%	Pass
Q32	12.0	48.5	60.5	60	0.83%	Pass
R14	10.5	48.5	59	60	-1.67%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
R15	10.0	48.5	58.5	60	-2.50%	Pass
R16	10.5	46.8	57.3	60	-4.50%	Pass
R17	11.0	47.6	58.6	60	-2.33%	Pass
R18	11.0	47.6	58.6	60	-2.33%	Pass
R19	11.0	47.6	58.6	60	-2.33%	Pass
R20	12.0	47.6	59.6	60	-0.67%	Pass
R21	12.0	47.6	59.6	60	-0.67%	Pass
R22	11.5	47.6	59.1	60	-1.50%	Pass
R23	11.0	47.6	58.6	60	-2.33%	Pass
R24	11.5	47.6	59.1	60	-1.50%	Pass
R25	11.5	47.6	59.1	60	-1.50%	Pass
R26	11.5	51.3	62.8	60	4.67%	Pass
R27	12.0	49.4	61.4	60	2.33%	Pass
R28	12.0	53.4	65.4	60	9.00%	Pass
R29	11.5	51.3	62.8	60	4.67%	Pass
R30	12.0	48.5	60.5	60	0.83%	Pass
R31	12.0	53.4	65.4	60	9.00%	Pass
R32	11.5	49.4	60.9	60	1.50%	Pass
S01	21.0	36.4	57.4	60	-4.33%	Pass
SW04	0.0	65.5	65.5	60	9.17%	Pass
SW06	0.0	62.3	62.3	60	3.83%	Pass
SW08	0.0	62.3	62.3	60	3.83%	Pass
SW10	0.0	63.9	63.9	60	6.50%	Pass
SW12	0.0	63.9	63.9	60	6.50%	Pass
SW14	0.0	65.5	65.5	60	9.17%	Pass
SW16	0.0	62.3	62.3	60	3.83%	Pass
SW18	0.0	59.5	59.5	60	-0.83%	Pass
SW20	0.0	59.5	59.5	60	-0.83%	Pass
SW22	0.0	58.2	58.2	60	-3.00%	Pass
SW24	0.0	59.5	59.5	60	-0.83%	Pass
SW26	0.0	59.5	59.5	60	-0.83%	Pass
SW28	0.0	59.5	59.5	60	-0.83%	Pass
SW30	0.0	59.5	59.5	60	-0.83%	Pass
SW32	0.0	62.3	62.3	60	3.83%	Pass
SW34	0.0	58.2	58.2	60	-3.00%	Pass
SW36	0.0	58.2	58.2	60	-3.00%	Pass
SW38	0.0	58.2	58.2	60	-3.00%	Pass
SW40	0.0	58.2	58.2	60	-3.00%	Pass
SW42	0.0	58.2	58.2	60	-3.00%	Pass
SW44	0.0	58.2	58.2	60	-3.00%	Pass
SW46	0.0	58.2	58.2	60	-3.00%	Pass
SW48	0.0	58.2	58.2	60	-3.00%	Pass
SW50	0.0	58.2	58.2	60	-3.00%	Pass
T03	13.5	50.4	63.9	60	6.50%	Pass
T04	14.0	46.8	60.8	60	1.33%	Pass
T05	16.0	42.2	58.2	60	-3.00%	Pass
T06	16.0	40.9	56.9	60	-5.17%	Pass
T07	14.0	42.2	56.2	60	-6.33%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
T08	13.5	46.8	60.3	60	0.50%	Pass
T09	15.0	42.2	57.2	60	-4.67%	Pass
T10	16.0	42.2	58.2	60	-3.00%	Pass
T10	22.0	37.4	59.4	60	-1.00%	Pass
T12	13.0	48.5	61.5	60	2.50%	Pass
T13	13.0	46.8	59.8	60	-0.33%	Pass
T14	14.0	47.6	61.6	60	2.67%	Pass
T15	14.5	47.6	62.1	60	3.50%	Pass
T16	12.5	47.6	60.1	60	0.17%	Pass
T17	11.0	49.4	60.4	60	0.67%	Pass
T18	11.0	47.6	58.6	60	-2.33%	Pass
T19	11.0	48.5	59.5	60	-0.83%	Pass
T20	11.0	52.4	63.4	60	5.67%	Pass
T21	11.5	50.4	61.9	60	3.17%	Pass
T22	11.5	50.4	61.9	60	3.17%	Pass
T34	14.0	47.6	61.6	60	2.67%	Pass
T35	14.0	45.1	59.1	60	-1.50%	Pass
T36	14.0	43.6	57.6	60	-4.00%	Pass
T37	14.0	46.8	60.8	60	1.33%	Pass
T38	15.0	43.6	58.6	60	-2.33%	Pass
T39	15.5	42.9	58.4	60	-2.67%	Pass
T40	16.5	45.1	61.6	60	2.67%	Pass
T41	17.0	43.6	60.6	60	1.00%	Pass
T42	17.0	45.1	62.1	60	3.50%	Pass
T43	16.5	44.4	60.9	60	1.50%	Pass
T44	17.5	43.6	61.1	60	1.83%	Pass
T45	16.5	44.4	60.9	60	1.50%	Pass
T46	15.5	44.4	59.9	60	-0.17%	Pass
T47	15.5	44.4	59.9	60	-0.17%	Pass
T48	14.5	46.8	61.3	60	2.17%	Pass
T49	12.0	48.5	60.5	60	0.83%	Pass
T50	10.0	51.3	61.3	60	2.17%	Pass
U01	23.0	38.5	61.5	60	2.50%	Pass
U03	16.5	42.2	58.7	60	-2.17%	Pass
U04	16.5	40.9	57.4	60	-4.33%	Pass
U05	16.5	42.2	58.7	60	-2.17%	Pass
U06	17.0	42.2	59.2	60	-1.33%	Pass
U07	14.0	42.2	56.2	60	-6.33%	Pass
U08	16.0	43.6	59.6	60	-0.67%	Pass
U09	17.0	42.2	59.2	60	-1.33%	Pass
U10	17.0	42.2	59.2	60	-1.33%	Pass
U11	16.5	42.2	58.7	60	-2.17%	Pass
U12	12.5	48.5	61	60	1.67%	Pass
U13	14.5	47.6	62.1	60	3.50%	Pass
U14	12.5	48.5	61	60	1.67%	Pass
U15	12.5	47.6	60.1	60	0.17%	Pass
U16	11.5	47.6	59.1	60	-1.50%	Pass
U17	12.0	49.4	61.4	60	2.33%	Pass

AB

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
U18	12.0	48.5	60.5	60	0.83%	Pass
U19	13.0	48.5	61.5	60	2.50%	Pass
U20	12.0	47.6	59.6	60	-0.67%	Pass
U21	13.5	47.6	61.1	60	1.83%	Pass
U23	15.0	47.6	62.6	60	4.33%	Pass
U26	25.0	29.4	54.4	60	-9.33%	Pass
U27	25.5	35.4	60.9	60	1.50%	Pass
U28	24.5	35.9	60.4	60	0.67%	Pass
U29	27.0	34.9	61.9	60	3.17%	Pass
U33	14.0	45.1	59.1	60	-1.50%	Pass
U34	16.0	45.9	61.9	60	3.17%	Pass
U35	13.0	46.8	59.8	60	-0.33%	Pass
U36	14.0	45.9	59.9	60	-0.17%	Pass
U37	15.5	45.1	60.6	60	1.00%	Pass
U38	16.5	43.6	60.1	60	0.17%	Pass
U39	NA	NA	NA	NA	NA	NA
U40	17.5	42.9	60.4	60	0.67%	Pass
U41	18.0	41.6	59.6	60	-0.67%	Pass
U42	17.5	42.9	60.4	60	0.67%	Pass
U43	33.0	28.8	61.8	60	3.00%	Pass
U44	33.0	29.1	62.1	60	3.50%	Pass
U45	32.5	26.7	59.2	60	-1.33%	Pass
U46	33.5	26.4	59.9	60	-0.17%	Pass
U47	12.0	47.6	59.6	60	-0.67%	Pass
U48	15.0	46.8	61.8	60	3.00%	Pass
U49	15.0	45.1	60.1	60	0.17%	Pass
U50	16.0	45.1	61.1	60	1.83%	Pass
V01	21.0	35.4	56.4	60	-6.00%	Pass
V03	13.5	45.1	58.6	60	-2.33%	Pass
V04	16.0	45.1	61.1	60	1.83%	Pass
V05	16.5	42.2	58.7	60	-2.17%	Pass
V06	17.0	42.2	59.2	60	-1.33%	Pass
V07	16.0	43.6	59.6	60	-0.67%	Pass
V08	16.0	43.6	59.6	60	-0.67%	Pass
V09	16.0	43.6	59.6	60	-0.67%	Pass
V10	16.0	45.1	61.1	60	1.83%	Pass
V11	17.0	42.2	59.2	60	-1.33%	Pass
V12	NA	NA	NA	NA	NA	NA
V13	12.5	46.8	59.3	60	-1.17%	Pass
V14	13.5	46.8	60.3	60	0.50%	Pass
V15	14.5	46.8	61.3	60	2.17%	Pass
V16	12.0	48.5	60.5	60	0.83%	Pass
V17	12.5	47.6	60.1	60	0.17%	Pass
V18	12.5	48.5	61	60	1.67%	Pass
V19	11.0	47.6	58.6	60	-2.33%	Pass
V20	11.5	47.6	59.1	60	-1.50%	Pass
V21	12.0	46.8	58.8	60	-2.00%	Pass
V22	12.0	47.6	59.6	60	-0.67%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
V23	15.0	45.9	60.9	60	1.50%	Pass
V26	29.0	31.2	60.2	60	0.33%	Pass
V27	29.0	32.3	61.3	60	2.17%	Pass
V28	29.0	30.1	59.1	60	-1.50%	Pass
V29	29.0	32.2	61.2	60	2.00%	Pass
V30	28.5	31.5	60	60	0.00%	Pass
V31	27.5	30.4	57.9	60	-3.50%	Pass
V32	28.0	32.3	60.3	60	0.50%	Pass
V33	17.0	45.1	62.1	60	3.50%	Pass
V34	15.0	45.1	60.1	60	0.17%	Pass
V35	14.0	45.1	59.1	60	-1.50%	Pass
V36	13.5	45.9	59.4	60	-1.00%	Pass
V37	16.5	45.9	62.4	60	4.00%	Pass
V38	17.5	45.1	62.6	60	4.33%	Pass
V39	17.5	43.6	61.1	60	1.83%	Pass
V40	19.0	41.6	60.6	60	1.00%	Pass
V41	20.0	41.9	61.9	60	3.17%	Pass
V42	20.0	39.1	59.1	60	-1.50%	Pass
V43	33.5	28.8	62.3	60	3.83%	Pass
V44	35.0	27.0	62	60	3.33%	Pass
V45	34.0	28.2	62.2	60	3.67%	Pass
V46	33.0	28.5	61.5	60	2.50%	Pass
V47	15.5	48.5	64	60	6.67%	Pass
V48	15.0	45.9	60.9	60	1.50%	Pass
V49	15.5	46.8	62.3	60	3.83%	Pass
V50	16.5	44.4	60.9	60	1.50%	Pass
W01	22.5	35.4	57.9	60	-3.50%	Pass
W03	15.0	43.6	58.6	60	-2.33%	Pass
W04	16.0	43.6	59.6	60	-0.67%	Pass
W05	16.5	43.6	60.1	60	0.17%	Pass
W06	16.0	42.2	58.2	60	-3.00%	Pass
W07	16.0	42.2	58.2	60	-3.00%	Pass
W08	16.5	42.2	58.7	60	-2.17%	Pass
W09	16.0	42.2	58.2	60	-3.00%	Pass
W10	16.0	45.1	61.1	60	1.83%	Pass
W11	17.0	42.2	59.2	60	-1.33%	Pass
W12	10.5	48.5	59	60	-1.67%	Pass
W13	11.0	47.6	58.6	60	-2.33%	Pass
W14	12.0	48.5	60.5	60	0.83%	Pass
W15	12.5	48.5	61	60	1.67%	Pass
W16	12.5	48.5	61	60	1.67%	Pass
W17	12.5	47.6	60.1	60	0.17%	Pass
W18	12.0	48.5	60.5	60	0.83%	Pass
W19	11.5	46.8	58.3	60	-2.83%	Pass
W20	11.0	48.5	59.5	60	-0.83%	Pass
W21	11.0	48.5	59.5	60	-0.83%	Pass
W22	12.0	48.5	60.5	60	0.83%	Pass
W23	15.0	45.9	60.9	60	1.50%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
W30	29.5	30.1	59.6	60	-0.67%	Pass
W31	30.0	30.1	60.1	60	0.17%	Pass
W32	32.5	29.8	62.3	60	3.83%	Pass
W47	15.5	44.4	59.9	60	-0.17%	Pass
W48	15.5	46.8	62.3	60	3.83%	Pass
W49	16.0	43.6	59.6	60	-0.67%	Pass
W50	16.0	44.4	60.4	60	0.67%	Pass
X01	22.0	38.5	60.5	60	0.83%	Pass
X03	15.0	45.1	60.1	60	0.17%	Pass
X04	16.0	46.8	62.8	60	4.67%	Pass
X05	16.0	43.6	59.6	60	-0.67%	Pass
X06	16.5	43.6	60.1	60	0.17%	Pass
X07	16.0	43.6	59.6	60	-0.67%	Pass
X08	16.5	42.2	58.7	60	-2.17%	Pass
X09	16.5	42.2	58.7	60	-2.17%	Pass
X10	14.5	45.1	59.6	60	-0.67%	Pass
X11	20.0	42.2	62.2	60	3.67%	Pass
X12	12.5	49.4	61.9	60	3.17%	Pass
X13	12.5	47.6	60.1	60	0.17%	Pass
X14	12.5	47.6	60.1	60	0.17%	Pass
X15	13.5	46.8	60.3	60	0.50%	Pass
X16	13.0	45.9	58.9	60	-1.83%	Pass
X17	13.0	47.6	60.6	60	1.00%	Pass
X18	13.5	46.8	60.3	60	0.50%	Pass
X19	12.5	46.8	59.3	60	-1.17%	Pass
X20	14.0	45.9	59.9	60	-0.17%	Pass
X21	13.0	47.6	60.6	60	1.00%	Pass
X22	12.0	45.1	57.1	60	-4.83%	Pass
X23	18.0	43.6	61.6	60	2.67%	Pass
X25	29.5	29.1	58.6	60	-2.33%	Pass
X26	30.5	30.4	60.9	60	1.50%	Pass
X27	30.5	29.4	59.9	60	-0.17%	Pass
X28	31.5	28.8	60.3	60	0.50%	Pass
X29	33.5	27.6	61.1	60	1.83%	Pass
X29	32.0	28.5	60.5	60	0.83%	Pass
X30	33.5	27.0	60.5	60	0.83%	Pass
X30	32.5	29.4	61.9	60	3.17%	Pass
X31	33.5	27.9	61.4	60	2.33%	Pass
X31	30.5	29.4	59.9	60	-0.17%	Pass
X32	32.0	29.8	61.8	60	3.00%	Pass
X32	32.0	28.8	60.8	60	1.33%	Pass
X33	33.0	27.0	60	60	0.00%	Pass
X33	32.0	27.3	59.3	60	-1.17%	Pass
X34	34.0	27.9	61.9	60	3.17%	Pass
X35	33.0	27.9	60.9	60	1.50%	Pass
X36	33.0	31.9	64.9	60	8.17%	Pass
X37	33.0	31.9	64.9	60	8.17%	Pass
X38	32.0	31.9	63.9	60	6.50%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
X39	34.0	31.2	65.2	60	8.67%	Pass
X40	33.5	28.5	62	60	3.33%	Pass
X41	32.5	31.2	63.7	60	6.17%	Pass
X42	34.5	29.8	64.3	60	7.17%	Pass
X43	34.0	30.4	64.4	60	7.33%	Pass
X44	35.5	29.1	64.6	60	7.67%	Pass
X45	35.0	29.1	64.1	60	6.83%	Pass
X46	34.5	29.1	63.6	60	6.00%	Pass
X47	15.0	45.1	60.1	60	0.17%	Pass
X48	15.0	46.8	61.8	60	3.00%	Pass
X49	16.0	45.9	61.9	60	3.17%	Pass
X50	16.0	44.4	60.4	60	0.67%	Pass
Y03	15.5	46.8	62.3	60	3.83%	Pass
Y04	15.5	45.1	60.6	60	1.00%	Pass
Y05	16.5	43.6	60.1	60	0.17%	Pass
Y06	16.0	43.6	59.6	60	-0.67%	Pass
Y07	15.0	43.6	58.6	60	-2.33%	Pass
Y08	14.0	43.6	57.6	60	-4.00%	Pass
Y09	14.0	43.6	57.6	60	-4.00%	Pass
Y10	14.5	45.1	59.6	60	-0.67%	Pass
Y10	31.0	30.4	61.4	60	2.33%	Pass
Y12	12.5	46.8	59.3	60	-1.17%	Pass
Y13	13.0	46.8	59.8	60	-0.33%	Pass
Y14	13.0	45.9	58.9	60	-1.83%	Pass
Y15	12.0	45.9	57.9	60	-3.50%	Pass
Y16	12.0	46.8	58.8	60	-2.00%	Pass
Y17	12.0	46.8	58.8	60	-2.00%	Pass
Y18	13.0	46.8	59.8	60	-0.33%	Pass
Y19	14.0	45.9	59.9	60	-0.17%	Pass
Y20	14.5	45.9	60.4	60	0.67%	Pass
Y21	14.0	45.1	59.1	60	-1.50%	Pass
Y22	15.0	45.9	60.9	60	1.50%	Pass
Y23	14.5	43.6	58.1	60	-3.17%	Pass
Y24	25.0	36.9	61.9	60	3.17%	Pass
Y25	26.5	32.7	59.2	60	-1.33%	Pass
Y25	26.0	29.4	55.4	60	-7.67%	Pass
Y26	27.5	31.5	59	60	-1.67%	Pass
Y26	29.0	31.2	60.2	60	0.33%	Pass
Y27	29.5	30.4	59.9	60	-0.17%	Pass
Y27	29.0	30.1	59.1	60	-1.50%	Pass
Y28	33.0	28.2	61.2	60	2.00%	Pass
Y28	31.5	28.5	60	60	0.00%	Pass
Y29	33.5	26.7	60.2	60	0.33%	Pass
Y30	33.5	25.9	59.4	60	-1.00%	Pass
Y31	34.0	26.7	60.7	60	1.17%	Pass
Y32	32.5	27.3	59.8	60	-0.33%	Pass
Y33	33.0	27.3	60.3	60	0.50%	Pass
Y33	33.0	26.7	59.7	60	-0.50%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
Y34	34.0	26.7	60.7	60	1.17%	Pass
Y35	34.0	26.7	60.7	60	1.17%	Pass
Y36	37.0	25.7	62.7	60	4.50%	Pass
Y37	37.5	27.3	64.8	60	8.00%	Pass
Y38	38.0	27.3	65.3	60	8.83%	Pass
Y39	38.0	27.9	65.9	60	9.83%	Pass
Y40	36.0	28.5	64.5	60	7.50%	Pass
Y41	36.0	29.1	65.1	60	8.50%	Pass
Y42	35.0	30.4	65.4	60	9.00%	Pass
Y43	32.0	30.4	62.4	60	4.00%	Pass
Y44	42.0	18.4	60.4	60	0.67%	Pass
Y45	35.0	29.1	64.1	60	6.83%	Pass
Y46	36.0	29.1	65.1	60	8.50%	Pass
Y47	14.5	48.5	63	60	5.00%	Pass
Y48	14.0	46.8	60.8	60	1.33%	Pass
Y49	14.0	45.1	59.1	60	-1.50%	Pass
Y50	15.5	43.6	59.1	60	-1.50%	Pass
Z01	33.5	31.9	65.4	60	9.00%	Pass
Z03	15.5	38.7	54.2	60	-9.67%	Pass
Z04	15.0	39.7	54.7	60	-8.83%	Pass
Z05	15.5	43.6	59.1	60	-1.50%	Pass
Z06	15.0	43.6	58.6	60	-2.33%	Pass
Z07	14.5	45.1	59.6	60	-0.67%	Pass
Z08	14.5	43.6	58.1	60	-3.17%	Pass
Z09	13.5	43.6	57.1	60	-4.83%	Pass
Z10	12.5	45.1	57.6	60	-4.00%	Pass
Z11	NA	NA	NA	NA	NA	NA
Z12	15.0	44.4	59.4	60	-1.00%	Pass
Z13	15.0	45.9	60.9	60	1.50%	Pass
Z14	15.0	45.9	60.9	60	1.50%	Pass
Z15	14.0	46.8	60.8	60	1.33%	Pass
Z16	13.0	45.9	58.9	60	-1.83%	Pass
Z17	13.0	45.9	58.9	60	-1.83%	Pass
Z18	15.0	45.1	60.1	60	0.17%	Pass
Z19	15.5	45.1	60.6	60	1.00%	Pass
Z20	14.0	45.1	59.1	60	-1.50%	Pass
Z21	24.5	37.4	61.9	60	3.17%	Pass
Z23	25.0	31.9	56.9	60	-5.17%	Pass
Z24	25.5	32.7	58.2	60	-3.00%	Pass
Z25	27.5	30.8	58.3	60	-2.83%	Pass
Z26	32.0	29.1	61.1	60	1.83%	Pass
Z27	34.0	26.2	60.2	60	0.33%	Pass
Z28	34.0	26.7	60.7	60	1.17%	Pass
Z29	35.5	25.9	61.4	60	2.33%	Pass
Z30	35.0	25.7	60.7	60	1.17%	Pass
Z31	33.5	25.7	59.2	60	-1.33%	Pass
Z32	33.5	26.7	60.2	60	0.33%	Pass
Z33	33.5	25.9	59.4	60	-1.00%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
Z34	34.0	25.7	59.7	60	-0.50%	Pass
Z35	34.5	26.7	61.2	60	2.00%	Pass
Z36	41.0	24.7	65.7	60	9.50%	Pass
Z37	40.0	24.2	64.2	60	7.00%	Pass
Z38	38.0	25.9	63.9	60	6.50%	Pass
Z39	37.0	27.6	64.6	60	7.67%	Pass
Z40	37.5	27.9	65.4	60	9.00%	Pass
Z41	36.5	28.8	65.3	60	8.83%	Pass
Z42	35.0	30.4	65.4	60	9.00%	Pass
Z43	33.5	28.8	62.3	60	3.83%	Pass
Z44	42.0	21.8	63.8	60	6.33%	Pass
Z45	36.0	29.4	65.4	60	9.00%	Pass
Z46	35.0	29.4	64.4	60	7.33%	Pass
Z47	15.0	45.9	60.9	60	1.50%	Pass
Z48	14.0	46.8	60.8	60	1.33%	Pass
Z49	14.0	44.4	58.4	60	-2.67%	Pass
Z50	14.5	43.6	58.1	60	-3.17%	Pass
AA01	37.5	18.7	56.2	60	-6.33%	Pass
AA03	16.5	40.9	57.4	60	-4.33%	Pass
AA04	16.0	39.7	55.7	60	-7.17%	Pass
AA05	17.0	38.5	55.5	60	-7.50%	Pass
AA06	16.5	38.5	55	60	-8.33%	Pass
AA07	16.0	43.6	59.6	60	-0.67%	Pass
AA08	15.5	43.6	59.1	60	-1.50%	Pass
AA09	16.0	43.6	59.6	60	-0.67%	Pass
AA10	14.5	45.1	59.6	60	-0.67%	Pass
AA11	22.5	40.9	63.4	60	5.67%	Pass
AA11	12.5	46.8	59.3	60	-1.17%	Pass
AA12	21.0	40.3	61.3	60	2.17%	Pass
AA13	20.0	40.3	60.3	60	0.50%	Pass
AA14	18.0	42.2	60.2	60	0.33%	Pass
AA15	17.5	42.9	60.4	60	0.67%	Pass
AA16	17.5	42.9	60.4	60	0.67%	Pass
AA17	17.5	43.6	61.1	60	1.83%	Pass
AA18	18.5	42.9	61.4	60	2.33%	Pass
AA19	21.0	40.3	61.3	60	2.17%	Pass
AA20	22.5	36.4	58.9	60	-1.83%	Pass
AA21	23.0	40.3	63.3	60	5.50%	Pass
AA22	25.5	33.1	58.6	60	-2.33%	Pass
AA23	29.5	31.5	61	60	1.67%	Pass
AA25	32.5	29.1	61.6	60	2.67%	Pass
AA26	33.0	28.8	61.8	60	3.00%	Pass
AA27	33.5	26.2	59.7	60	-0.50%	Pass
AA28	35.0	25.9	60.9	60	1.50%	Pass
AA29	36.5	25.4	61.9	60	3.17%	Pass
AA30	35.0	25.4	60.4	60	0.67%	Pass
AA31	35.0	25.4	60.4	60	0.67%	Pass
AA32	34.5	25.7	60.2	60	0.33%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
AA33	37.0	23.0	60	60	0.00%	Pass
AA34	38.0	24.2	62.2	60	3.67%	Pass
AA35	38.0	25.2	63.2	60	5.33%	Pass
AA36	40.0	24.7	64.7	60	7.83%	Pass
AA37	40.0	24.9	64.9	60	8.17%	Pass
AA38	38.5	24.9	63.4	60	5.67%	Pass
AA39	37.5	26.4	63.9	60	6.50%	Pass
AA40	38.0	26.4	64.4	60	7.33%	Pass
AA41	37.0	28.5	65.5	60	9.17%	Pass
AA42	36.0	29.8	65.8	60	9.67%	Pass
AA43	35.0	29.1	64.1	60	6.83%	Pass
AA44	35.0	29.4	64.4	60	7.33%	Pass
AA45	34.0	29.8	63.8	60	6.33%	Pass
AA46	35.5	27.3	62.8	60	4.67%	Pass
AA47	15.5	45.9	61.4	60	2.33%	Pass
AA48	14.0	45.9	59.9	60	-0.17%	Pass
AA49	14.5	45.1	59.6	60	-0.67%	Pass
AA50	16.0	43.6	59.6	60	-0.67%	Pass
AB01	39.5	18.2	57.7	60	-3.83%	Pass
AB03	19.0	35.4	54.4	60	-9.33%	Pass
AB04	18.5	36.4	54.9	60	-8.50%	Pass
AB06	19.0	42.2	61.2	60	2.00%	Pass
AB07	19.5	38.5	58	60	-3.33%	Pass
AB08	21.0	39.7	60.7	60	1.17%	Pass
AB09	21.0	40.9	61.9	60	3.17%	Pass
AB10	20.5	40.9	61.4	60	2.33%	Pass
AB11	21.5	39.7	61.2	60	2.00%	Pass
AB12	30.0	30.4	60.4	60	0.67%	Pass
AB13	28.5	33.6	62.1	60	3.50%	Pass
AB14	27.5	31.9	59.4	60	-1.00%	Pass
AB15	27.0	32.7	59.7	60	-0.50%	Pass
AB16	25.5	37.9	63.4	60	5.67%	Pass
AB17	27.0	37.9	64.9	60	8.17%	Pass
AB18	23.0	37.9	60.9	60	1.50%	Pass
AB19	25.0	37.9	62.9	60	4.83%	Pass
AB20	28.0	35.4	63.4	60	5.67%	Pass
AB21	29.0	31.5	60.5	60	0.83%	Pass
AB22	34.0	26.4	60.4	60	0.67%	Pass
AB23	33.0	29.1	62.1	60	3.50%	Pass
AB24	37.5	22.2	59.7	60	-0.50%	Pass
AB24	32.0	23.0	55	60	-8.33%	Pass
AB25	34.5	25.2	59.7	60	-0.50%	Pass
AB26	36.5	25.2	61.7	60	2.83%	Pass
AB27	36.5	25.7	62.2	60	3.67%	Pass
AB28	34.5	25.2	59.7	60	-0.50%	Pass
AB29	36.0	25.4	61.4	60	2.33%	Pass
AB33	35.5	24.5	60	60	0.00%	Pass
AB34	39.0	23.2	62.2	60	3.67%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
AB35	39.0	24.7	63.7	60	6.17%	Pass
AB36	39.5	24.9	64.4	60	7.33%	Pass
AB37	39.5	24.9	64.4	60	7.33%	Pass
AB38	39.5	25.4	64.9	60	8.17%	Pass
AB39	39.5	25.2	64.7	60	7.83%	Pass
AB40	39.0	25.7	64.7	60	7.83%	Pass
AB41	37.0	27.0	64	60	6.67%	Pass
AB42	35.0	28.5	63.5	60	5.83%	Pass
AB43	34.0	30.1	64.1	60	6.83%	Pass
AB44	34.5	28.2	62.7	60	4.50%	Pass
AB45	37.0	28.8	65.8	60	9.67%	Pass
AB46	36.0	28.8	64.8	60	8.00%	Pass
AB47	17.0	45.9	62.9	60	4.83%	Pass
AB48	15.5	45.1	60.6	60	1.00%	Pass
AB49	15.5	45.1	60.6	60	1.00%	Pass
AB50	16.5	44.4	60.9	60	1.50%	Pass
AB50	17.5	47.4	64.9	60	8.17%	Pass
AC01	39.5	17.9	57.4	60	-4.33%	Pass
AC03	26.0	29.8	55.8	60	-7.00%	Pass
AC04	24.5	31.2	55.7	60	-7.17%	Pass
AC05	26.0	31.2	57.2	60	-4.67%	Pass
AC06	25.5	37.4	62.9	60	4.83%	Pass
AC07	23.5	36.4	59.9	60	-0.17%	Pass
AC08	25.0	34.5	59.5	60	-0.83%	Pass
AC09	28.0	31.9	59.9	60	-0.17%	Pass
AC10	31.0	31.2	62.2	60	3.67%	Pass
AC11	30.0	29.8	59.8	60	-0.33%	Pass
AC13	34.5	24.9	59.4	60	-1.00%	Pass
AC14	34.0	28.8	62.8	60	4.67%	Pass
AC15	31.5	31.2	62.7	60	4.50%	Pass
AC16	36.0	22.8	58.8	60	-2.00%	Pass
AC17	32.5	24.2	56.7	60	-5.50%	Pass
AC18	33.5	23.4	56.9	60	-5.17%	Pass
AC19	30.5	29.1	59.6	60	-0.67%	Pass
AC20	32.0	29.8	61.8	60	3.00%	Pass
AC21	34.5	22.4	56.9	60	-5.17%	Pass
AC22	35.5	20.5	56	60	-6.67%	Pass
AC23	37.5	22.2	59.7	60	-0.50%	Pass
AC24	36.0	26.4	62.4	60	4.00%	Pass
AC25	35.0	23.6	58.6	60	-2.33%	Pass
AC26	37.5	20.0	57.5	60	-4.17%	Pass
AC27	37.5	23.4	60.9	60	1.50%	Pass
AC28	36.5	20.1	56.6	60	-5.67%	Pass
AC29	36.5	24.7	61.2	60	2.00%	Pass
AC34	37.0	23.6	60.6	60	1.00%	Pass
AC35	39.5	22.4	61.9	60	3.17%	Pass
AC36	38.0	22.8	60.8	60	1.33%	Pass
AC37	39.5	22.2	61.7	60	2.83%	Pass

Table IA
IE Test Results

Test Zone	Chipped Depth (in)	IE Thickness (in)	IE + Chipped (in)	Expected Thickness (in)	Percent Error (±10% Max.)	Pass/Fail
AC38	38.5	23.0	61.5	60	2.50%	Pass
AC39	39.0	23.0	62	60	3.33%	Pass
AC40	39.5	22.0	61.5	60	2.50%	Pass
AC41	38.5	25.2	63.7	60	6.17%	Pass
AC42	37.0	25.7	62.7	60	4.50%	Pass
AC43	34.5	29.1	63.6	60	6.00%	Pass
AC44	34.5	27.9	62.4	60	4.00%	Pass
AC45	35.5	27.9	63.4	60	5.67%	Pass
AC46	35.0	27.6	62.6	60	4.33%	Pass
AC47	34.0	26.4	60.4	60	0.67%	Pass
AC48	32.5	28.2	60.7	60	1.17%	Pass
AC49	32.0	32.3	64.3	60	7.17%	Pass
AD03	31.5	25.7	57.2	60	-4.67%	Pass
AD04	31.5	27.9	59.4	60	-1.00%	Pass
AD05	33.5	27.3	60.8	60	1.33%	Pass
AD06	31.5	30.4	61.9	60	3.17%	Pass
AD07	31.5	30.4	61.9	60	3.17%	Pass
AD08	36.0	24.7	60.7	60	1.17%	Pass
AD09	36.5	25.2	61.7	60	2.83%	Pass
AD10	37.5	23.4	60.9	60	1.50%	Pass
AD11	37.5	24.7	62.2	60	3.67%	Pass
AD35	40.5	19.7	60.2	60	0.33%	Pass
AD36	39.0	19.4	58.4	60	-2.67%	Pass
AD37	39.0	20.0	59	60	-1.67%	Pass
AD43	34.0	27.9	61.9	60	3.17%	Pass
AD44	35.0	29.8	64.8	60	8.00%	Pass
AD45	32.0	29.4	61.4	60	2.33%	Pass
AE03	36.0	22.6	58.6	60	-2.33%	Pass
AE04	36.0	23.0	59	60	-1.67%	Pass
AE05	39.5	20.1	59.6	60	-0.67%	Pass
AE06	39.0	20.8	59.8	60	-0.33%	Pass

Appendix B

GN Northern Laboratory Results

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GN NORTHERN COMPRESSIVE STRENGTH FOR DRILLED CONCRETE CORES

**ALL CORES CAPPED MET THE LENGTH/ DIAMETER RATIO

BREAK MACH.:C000076 STEEL RULE:G000020 *AGE OF CORES TO BE FILLED OUT BY BNI

CORE ID	JOB #	WORK ORDER #	CAP TYPE	CROSS SECTION DIM. AVE. (IN.)	AREA (IN.^2)	LOAD ILBS.	COMP. STRESS (PSI)	FRACTURE TYPE	LENGTH	LENGTH CAPPED	WEIGHT	UNIT WEIGHT	BREAK DAY (AGE OF CORES*)
1A	Y01-136	B374-02	SULPHUR	3.630	10.35	59135	5710	A	7.13	7.31	6.49	152.00	
1B	Y01-136	B374-02	SULPHUR	3.635	10.38	63665	6130	A	7.27	7.49	6.58	150.70	
1C	Y01-136	B374-02	SULPHUR	3.635	10.38	57635	5550	D	7.30	7.49	6.60	150.50	
1D	Y01-136	B374-02	SULPHUR	3.650	10.46	55445	5300	D	7.32	7.52	6.80	153.40	
2A	Y01-136	B374-02	SULPHUR	3.660	10.52	46790	4450	D	7.33	7.55	6.77	151.70	
2B	Y01-136	B374-02	SULPHUR	3.660	10.52	56875	5410	A	7.30	7.52	6.78	152.50	
2C	Y01-136	B374-02	SULPHUR	3.650	10.46	49955	4780	C	7.31	7.52	6.73	152.00	
2D	Y01-136	B374-02	SULPHUR	3.650	10.46	44540	4260	D	7.31	7.48	6.76	152.70	
3A	Y01-136	B374-02	SULPHUR	3.645	10.44	59915	5740	B	7.30	7.55	6.74	151.30	
4A	Y01-136	B374-02	SULPHUR	3.660	10.52	56950	5410	A	7.25	7.42	6.60	149.50	
4B	Y01-136	B374-02	SULPHUR	3.655	10.49	54365	5180	D	7.39	7.56	6.90	153.80	
5A	Y01-136	B374-02	SULPHUR	3.640	10.41	59425	5710	A	7.30	7.50	6.67	151.70	
5B	Y01-136	B374-02	SULPHUR	3.645	10.44	60295	5780	C	7.32	7.49	6.61	149.50	
5D	Y01-136	B374-02	SULPHUR	3.660	10.52	42400	4030	A	7.29	7.51	6.66	150.10	
6A	Y01-136	B374-02	SULPHUR	3.655	10.49	54370	5180	C	7.10	7.24	6.56	152.20	
6B	Y01-136	B374-02	SULPHUR	3.645	10.44	60685	5810	C	7.33	7.56	6.75	151.70	
6C	Y01-136	B374-02	SULPHUR	3.650	10.46	62610	5990	A	6.86	7.06	6.45	155.30	
6D	Y01-136	B374-02	SULPHUR	3.650	10.46	60530	5790	D	7.34	7.49	6.78	152.50	
7B	Y01-136	B374-02	SULPHUR	3.655	10.44	54870	5260	C	7.30	7.54	6.73	151.80	
7C	Y01-136	B374-02	SULPHUR	3.645	10.44	50325	4820	D	7.33	7.57	6.77	153.00	
8A	Y01-136	B374-02	SULPHUR	3.645	10.44	63210	6050	D	7.15	7.22	6.64	153.80	
8B	Y01-136	B374-02	SULPHUR	3.640	10.41	59655	5730	C	7.25	7.52	6.64	152.10	
8C	Y01-136	B374-02	SULPHUR	3.635	1038	52335	5040	A	7.40	7.60	6.73	151.40	
8D	Y01-136	B374-02	SULPHUR	3.645	10.44	47120	4510	A	7.40	7.61	6.83	152.80	
8E	Y01-136	B374-02	SULPHUR	3.640	10.41	50085	4810	C	7.34	7.51	6.69	151.30	
9A	Y01-136	B374-02	SULPHUR	3.640	10.41	43025	4130	D	7.34	7.55	6.84	154.70	
9B	Y01-136	B374-02	SULPHUR	3.640	10.41	51415	4940	D	7.25	7.44	6.64	152.10	
9C	Y01-136	B374-02	SULPHUR	3.645	10.44	49205	4710	A	7.35	7.57	6.78	152.80	
9D	Y01-136	B374-02	SULPHUR	3.655	10.49	61030	5820	C	7.29	7.51	6.74	152.30	

ASTM C42-99, C39-01

TEST PERFORMED BY: B. Pound / M. Peterson
10-18-02

REVIEWED BY: [signature]

DATE: 10-18-02

BNI/WTP
Quality Assurance Department

Quality Control Surveillance Report

Document Number: 24590-WTP-SV-QC-02-144	Rev: 0	Date: 10-22-02
Title: GN Northern Testing Drilled Cores of Concrete		
Originator Fred Blanks	Responsible Organization: WTP Construction	

Requirement(s): (Procedure/Specification/Applicable Documents)

GN Northern's Testing Procedures: P-C39-01 and P-C617-98

ASTM C 42/C 99

Description/Details:

10-18-02 Monitored the capping and compressive strength testing of 29 concrete core specimens. The capping and compressive strength testing of the drilled cores were performed by GN Northern's Mark Peterson and Bernie Pound. The cores were capped as detailed in P-617-98. The compressive strength tests were conducted in accordance with P-C39-01 and ASTM C 42/C 99.

10-22-02 Revieved testing documentation. The testing documentation comforms to the requirements of ASTM's C 39/C-01 and C 42/C 99. See Attached "GN Northern Compressive Strength For Drilled Concrete Cores".

This surveillance revealed that the requirements of the procedures and standards were met.

Person(s) Contacted: Mark Peterson, Bernie Pound	CAR/DR Issued: ☐ Yes ☒ No	CAR/DR Number(s): NA
	Results: ☒ Sat ☐ Unsat	☒ ☐ ☐

Comments:

The testing of these 29 core specimens is a requirement of 24590-WTP-NCR-CON-02-093 Rev. 0, page 9 "Verification of Soundness".

Follow-Up Recommended ☐ Yes ☒ No Follow-Up Date: NA	Responsible Manager: (Printed Name) S. GOLDSMITH S. Thieme	
QCE Signature: Fred Blanks *Fred Blanks*	Date: 10-22-02	FQCM Signature: [signature]	Date: 10-22-02

Appendix C

Core Photographs

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Figure 1 - Core #1

Figure 2 - Core #1 (rolled 180 degrees, typical)

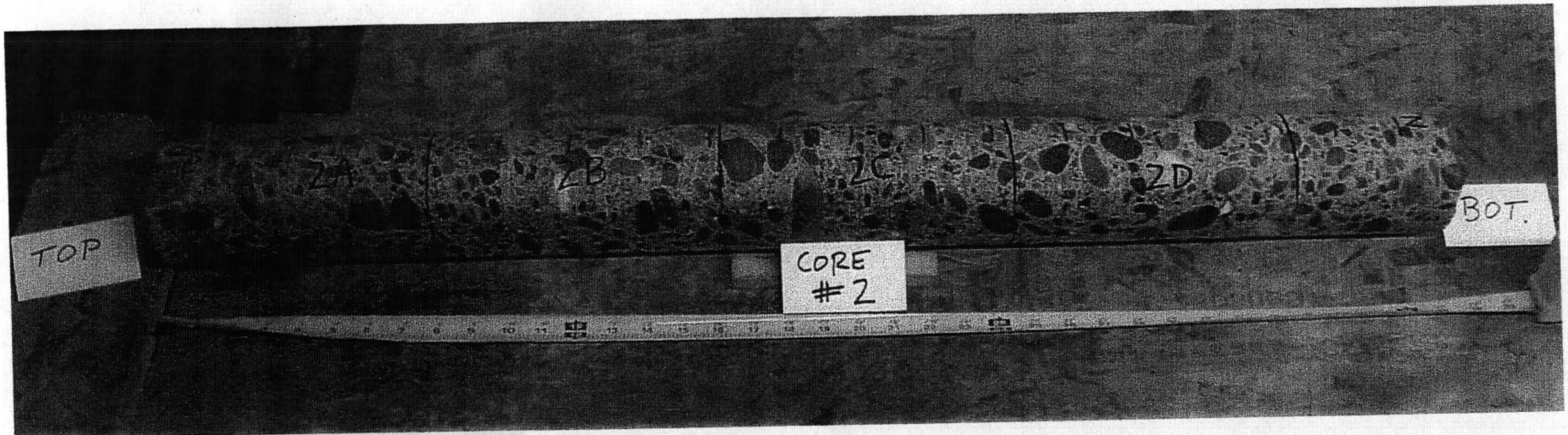

Figure 3 - Core #2

Figure 4 - Core #2

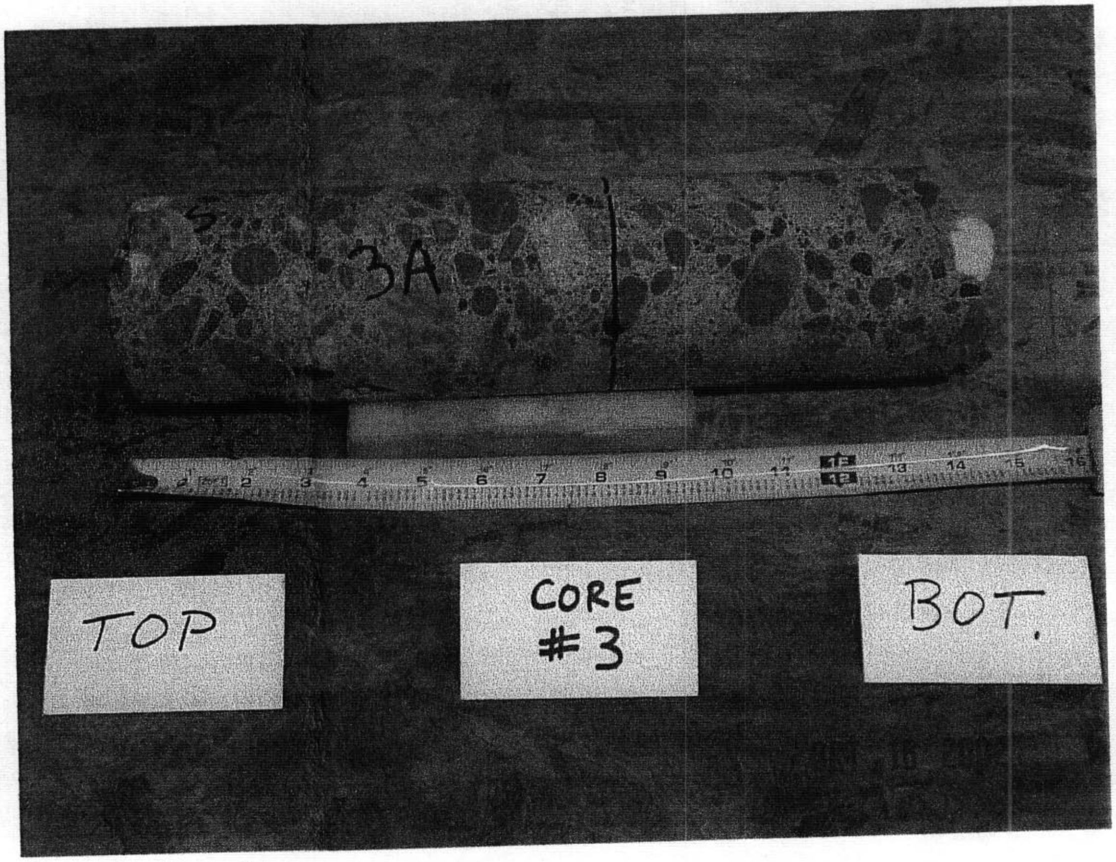

Figure 5 - Core #3

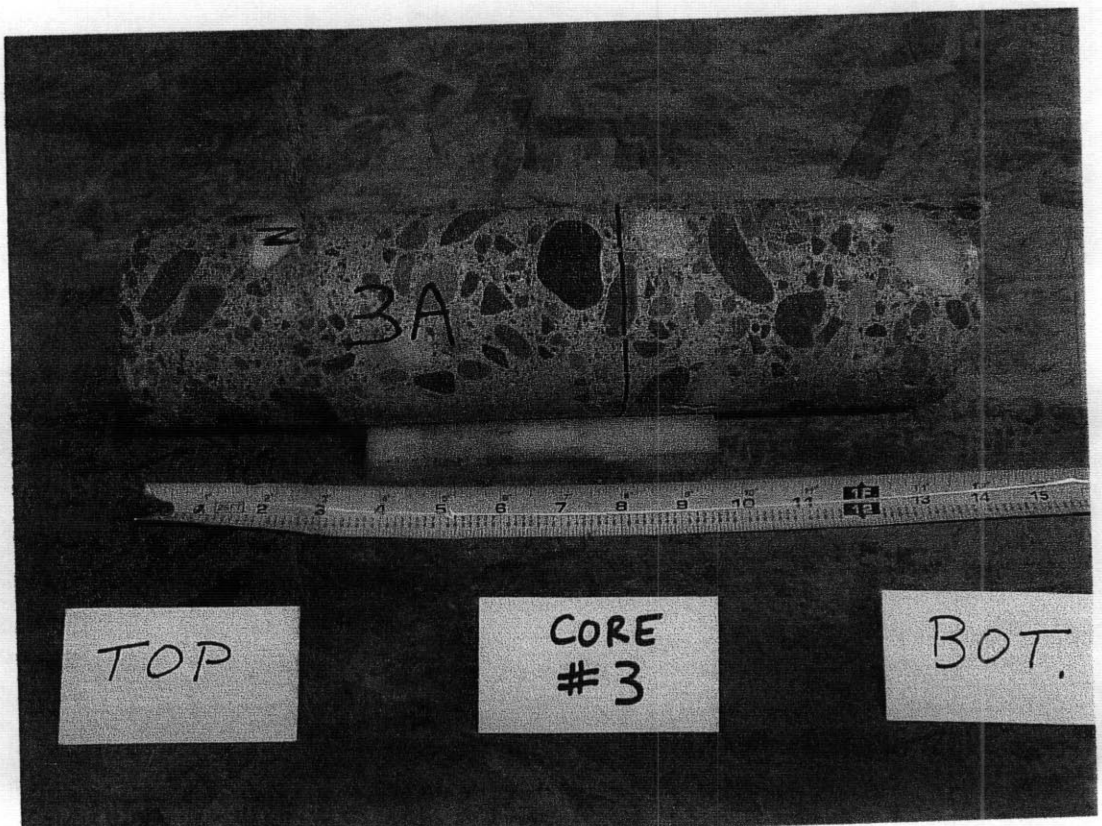

Figure 6 - Core #3

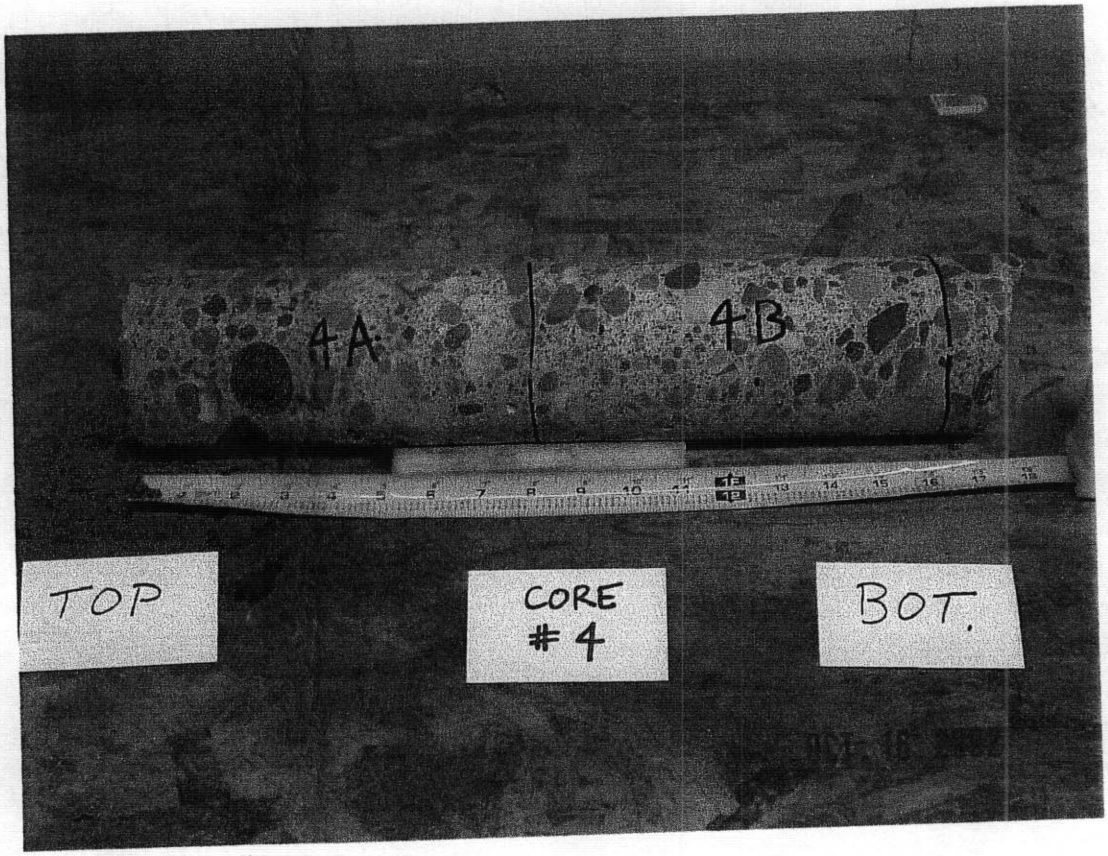

Figure 7 - Core #4

Figure 8 - Core #4

Figure 9 - Core #5

Figure 10 - Core #5

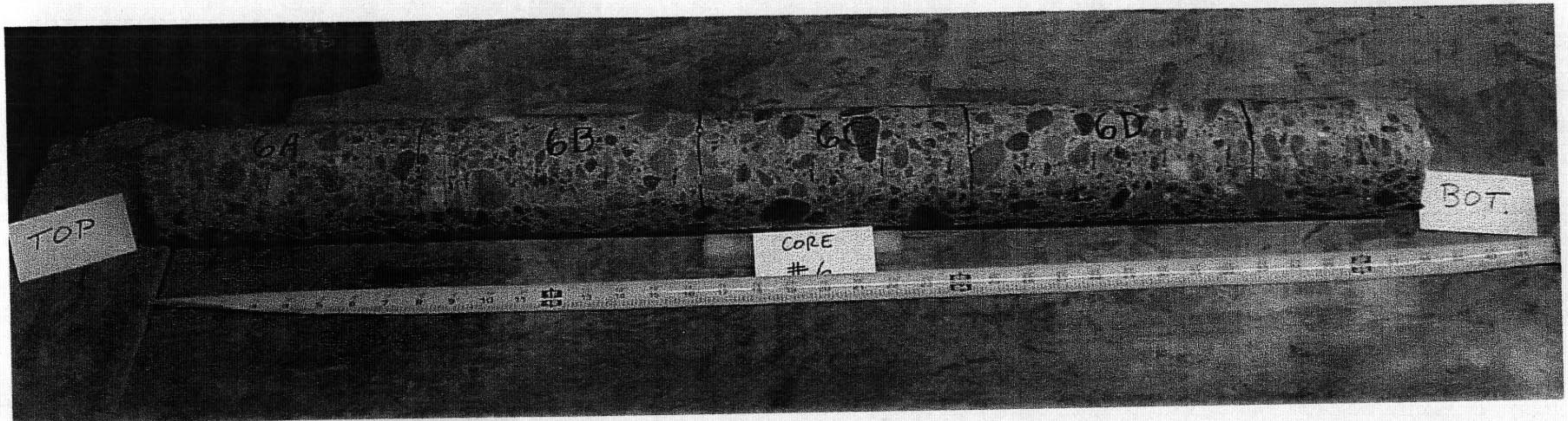

Figure 11 - Core #6

Figure 12 - Core #6

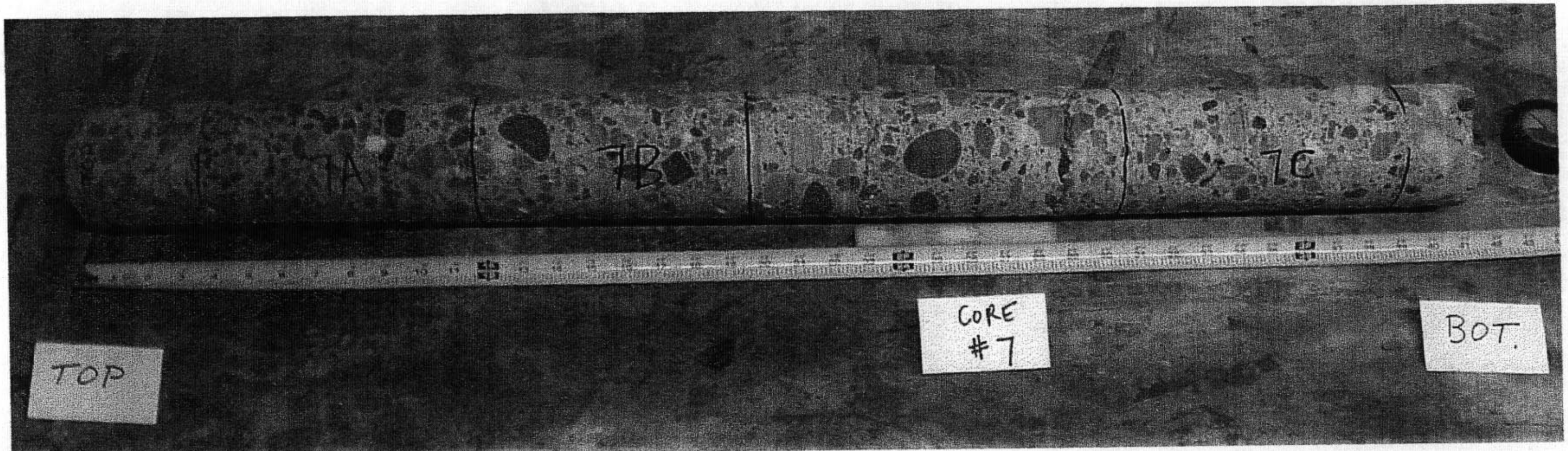

Figure 13 - Core #7

Figure 14 - Core #7, core broke between sections 7B and 7C

Figure 15 - Core #8

Figure 16 - Core #8

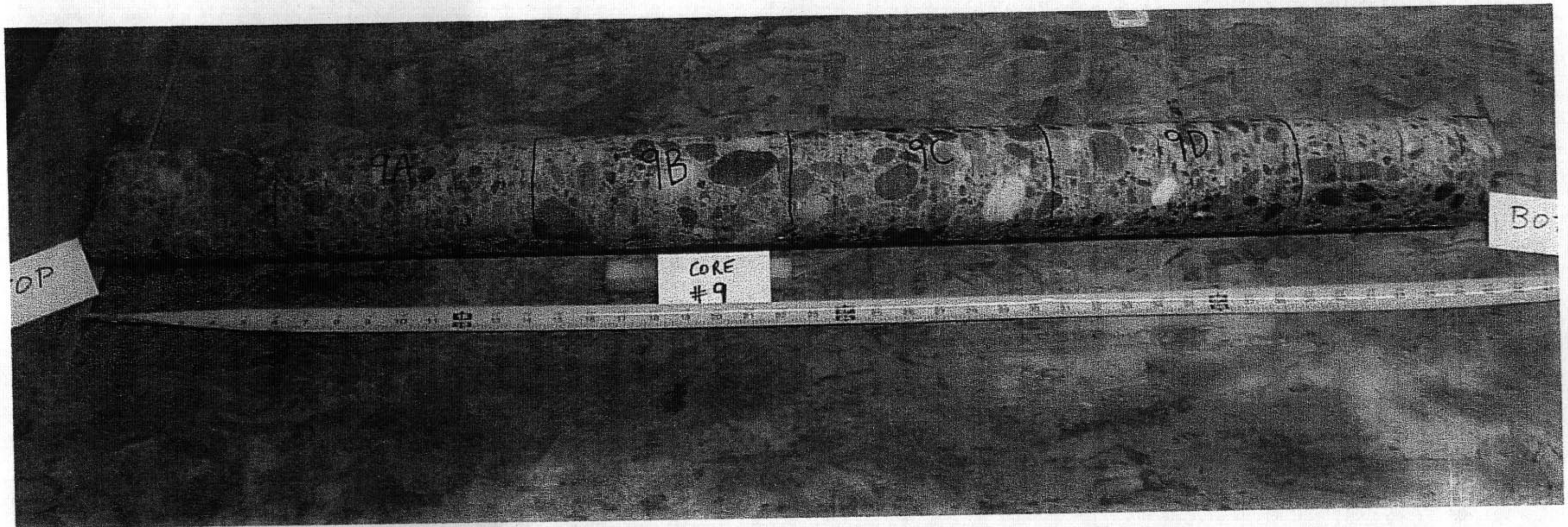

Figure 17 - Core #9, top 3 to 5 inches cracked and broke

Figure 18 - Core #9

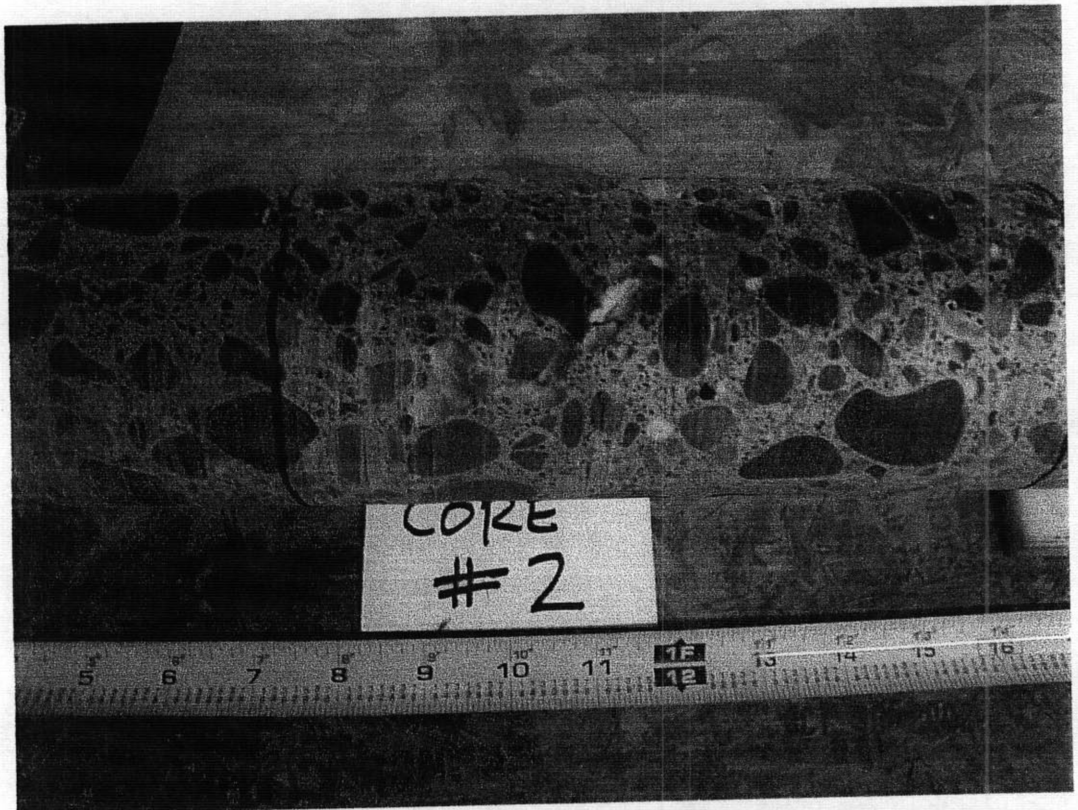

Figure 19 - Example Voids from Core #2

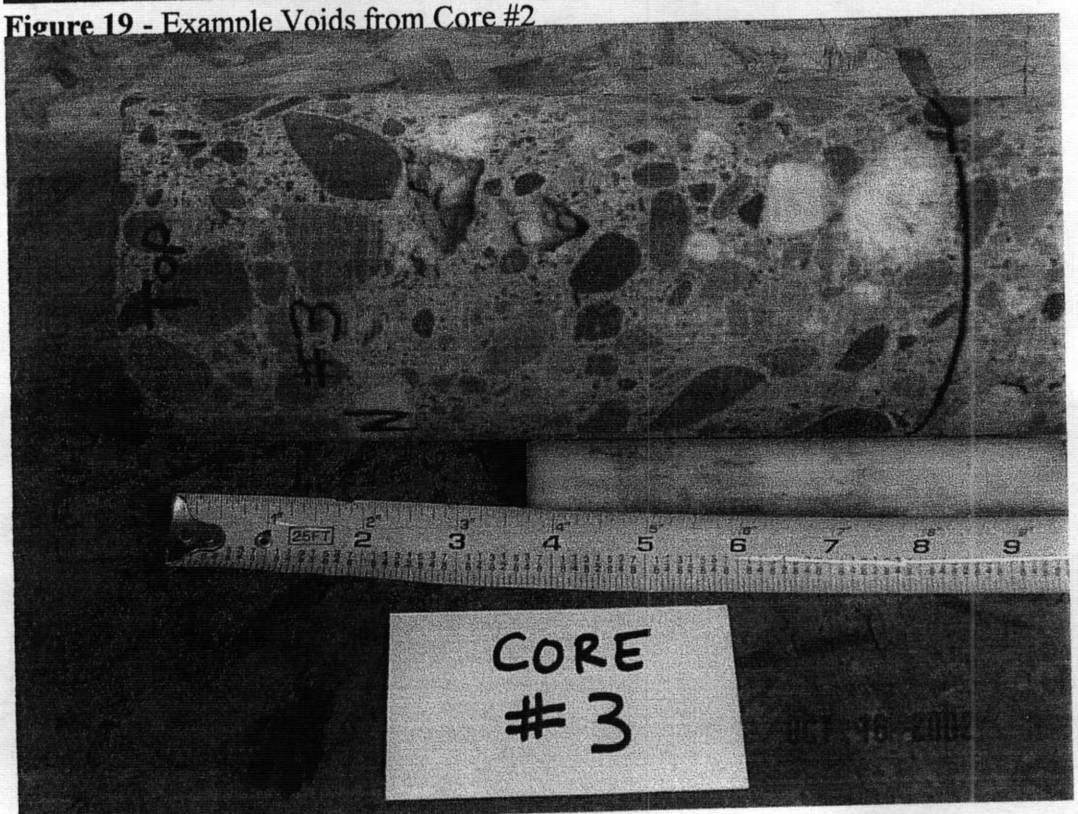

Figure 20 - Example Voids from Core #3

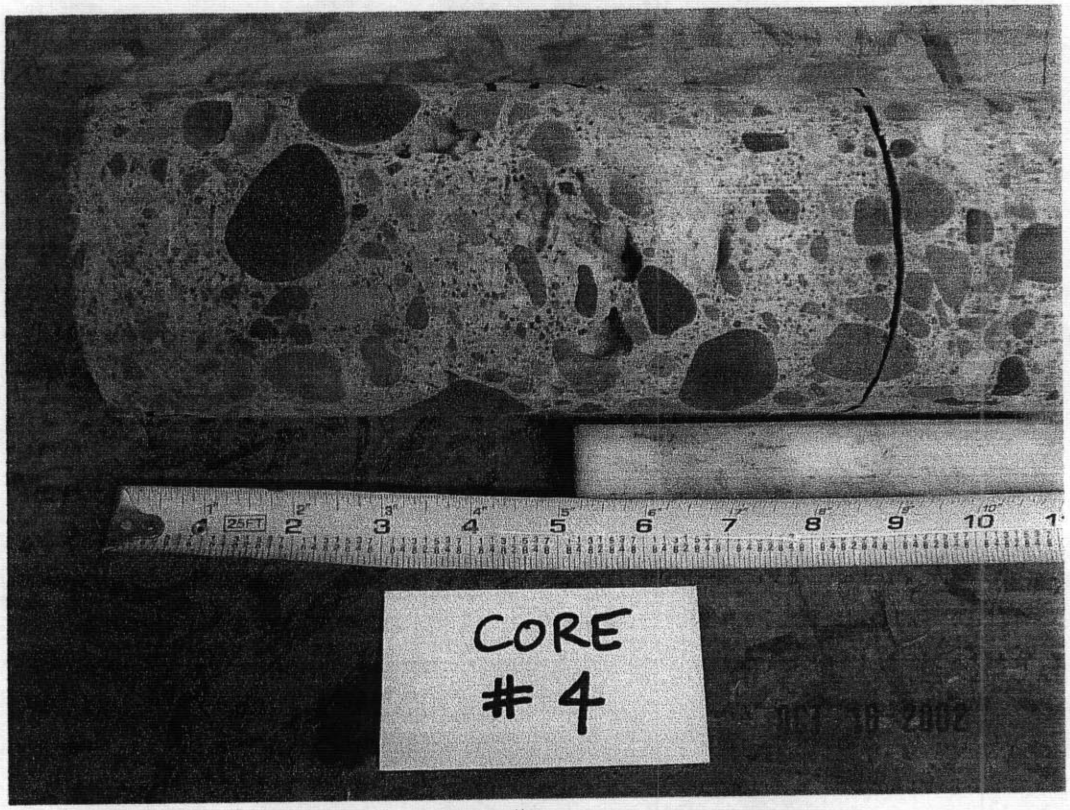

Figure 21 - Example Voids from Core #4

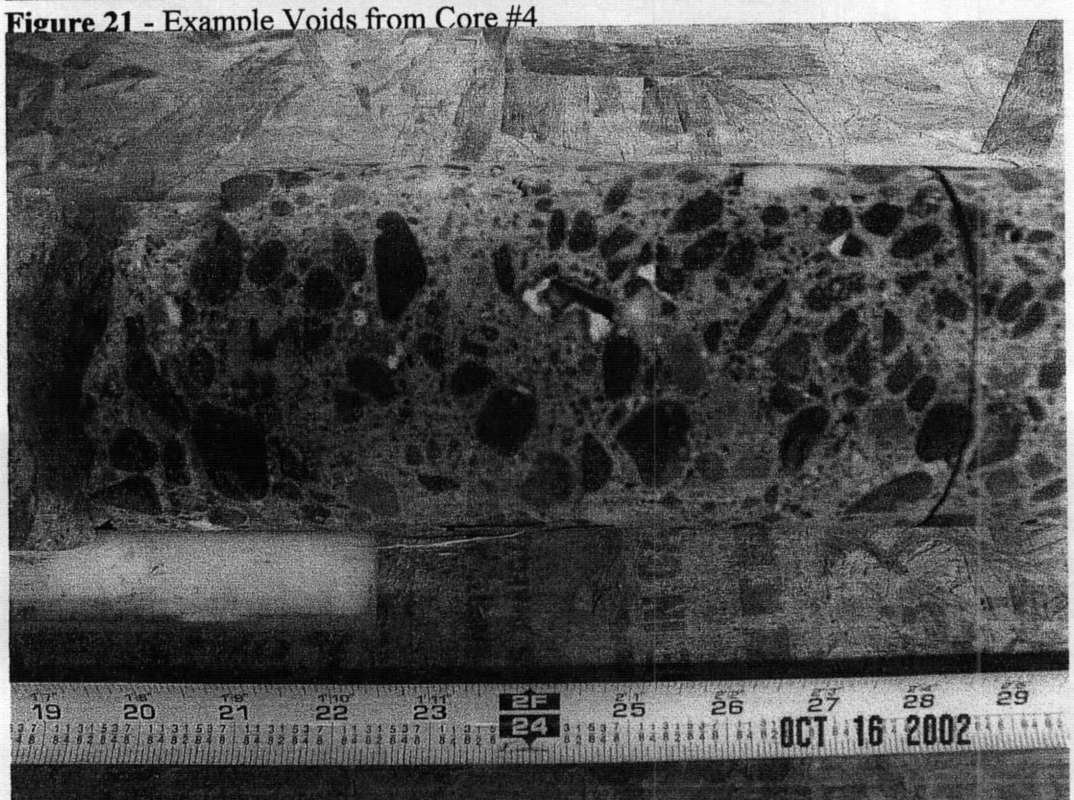

Figure 22 - Example Voids from Core #5

Best Available Copy

Figure 23 - Example Voids from Core #8

Figure 24 - Example Voids from Core #9